## Chemical Engineering JUNE 1955

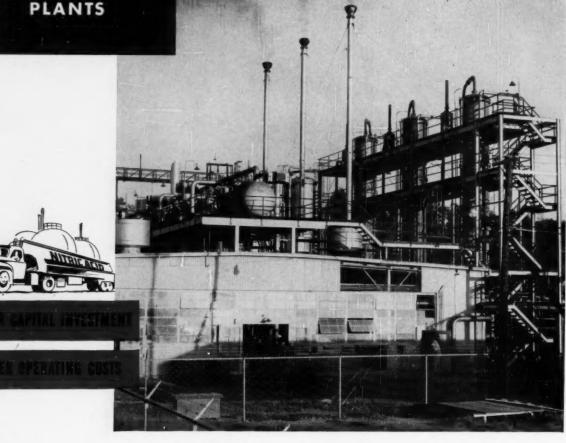
Report on
TRAINING
Page 268

You asked for it!

Today's techniques in SOLIDS-LIQUID SEPARATION

64 pages of know-how correlated & evaluated by nine specialists exclusively for you PLANTS

Girdler nitric acid plants employ the well-known Du Pont process, using high-pressure catalytic oxidation, to produce nitric acid. These plants offer greater economy, in both investment and operating costs, than atmospheric or low-pressure units. With the high-pressure process 55%-60% nitric acid is produced with efficient use of catalysts, and with lower utility requirements.



#### How you save money with GIRDLER know-how

WHEN you come to Girdler for nitric acid facilities, you get the benefit of the vast experience of DuPont as well as Girdler. DuPont's agreement with Girdler has combined the know-how of both companies. Moreover, Girdler has unsurpassed experience in building plants for the production of ammonium nitrate.

Because of this experience and new Girdler developments in nitric acid plants, you are assured substantial savings in capital investment and in operating costs when you specify Girdler. Mail coupon for bulletin on Girdler nitric acid plants.

A DIVISION OF NATIONAL CYLINDER GAS COMPANY

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GAS PROCESSES DIVISION: New York, San Francisco. In Canada: Girdler Corporation of Canada Limited, Toronto

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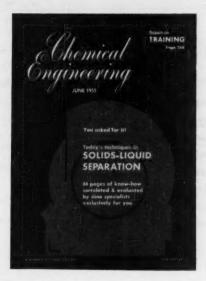
THE GIRDLER COMPANY 224 East Broadway Louisville 1, Kentucky

Please send copy of new Bulletin on Girdler Nitric

\_Zone \_ State\_\_

My Name\_

My Position



#### **Moving-Bed Processes**

Next month's feature report will deal with moving-bed processes—a pioneering, 32-page interpretive survey of this entire, fast-growing field.

It will be a comprehensive roundup of moving (not fluidized) bed techniques for contacting solids and gases:

Fundamental principles, engineering design, commercial operations, advantages and limitations, new and improved processes, what's ahead in the chemical, petroleum and metallurgical fields.

Why do we publish this report now?

• Because the moving-bed technique has vast potential for new uses throughout the process industries.

 Because there's a real need for a comprehensive evaluation of the entire field in one reference.

• Because the author—who spent over five months making this study has come up with authoritative data of value to engineers in development, design, operations, management.

You shouldn't miss Moving-Bed Processes next month!—JRC



### What's doing in today's techniques for liquid-solids separation.

You'll find the answers in this month's 64-page report on Solids-Liquid Separation. First section tells how to approach your problem. Following sections evaluate equipment and operating principles for screening, filtration, centrifugation, cycloning, thickening. This report—which we've worked on for a year—is our answer to your requests for a critical roundup of this unit operation. (p. 175)



#### How much does a high stack cost?

These stacks are important in the control of atmospheric pollution. But what do they cost? Here, for the first time in one convenient reference, are up-to-date and detail data on comparative costs. (p. 239)



#### New trick for heat exchanger men.

What: A numerical way to estimate the exchanger area of a shell-and-tube heat exchanger. Why: Faster, more accurate



Please turn page

## GUIDED TOUR

than the usual graphical method. For all engineers working with exchangers. (p. 245)



#### More help in finding cost data.

Here's an annotated bibliography to 186 articles published in 1954 on costs and cost estimating. It helps you locate cost data quickly, supplements the 1947-1953 index we published last October. (p. 247)



#### How industry trains its engineers.

New nationwide survey shows that training programs vary from formal courses to "a handbook and a handshake." Job rotation is the major ingredient in most chemical companies training recipe. (p. 268)



#### What to expect from plastic valves.

You can look forward to wider use of injection-molded globe valves; plastic diaphragm valves will also remain popular. Here are comparative data you can put to good use in your own selection. (p. 280)



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Equipment Cost Index	322	Chemical Engineering (with Chemical & Metallurgi-
CHEMICAL ECONOMICS		Chemical Engineering (with Chemical & Metallurgi- cal Engineering) is published monthly with an addi- tional issue in Mid-October by McGraw-Hill Publish- ing Company, Inc., James H. McGraw (1860-1948), Founder. Publication Office: 99-129 North Broadway,
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Man of the Month	377	
	378	To keep pace with the chemical, petrochemical and
	478	chemical process industries, more engineers subscribe to Chemical Engineering than to any other publication.
	467	Total net paid circulation of this issue:
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### Here's why you should investigate the Swenson Spray Drying Process?

Perfected through more than 60 years of experience and research, Swenson Spray Dryers provide many important advantages. They have opened the profit door to many new fields and have made practical the developments and discoveries originated in the laboratory.

Swenson Spray Dryers produce almost instantaneous drying. Each tiny particle of the finished product is uniformly similar to the others. In almost every case, no further processing is necessary before packaging and shipping. Significant savings in overall processing costs and time are the result.

Quality is at an efficient high when a Swenson

Spray Dryer is used. You get selected variations in atomization, feed concentration, feed temperature and air temperature. Such factors enable you to cut production costs to a minimum. You get a better product from fewer processing steps and a lower total product cost.

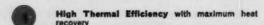
Swenson maintains a complete plant-scale Spray Dryer Laboratory for the purpose of conducting research, to develop new equipment and techniques, to provide new applications and to evaluate the potential of a customer's product.

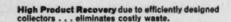
#### SWENSON EVAPORATOR CO.

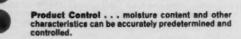
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High Efficiency Atomization that can be con-trolled provides many variations in atomizing.

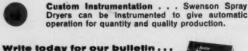
#### SWENSON SPRAY DRYING OFFERS THESE FEATURES:











containing full details about Swenson Spray Dryers—D-105. Indicate in your letter if you would like to have an engineer call to counsel with you.

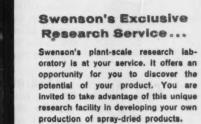




17/1:1/

Proved Engineering for the Process Industries Since 1889





Here's a gas-heated Swenson Spray Dryer in a chemical processing plant.

## OIL-FREE AIR?

You'll be three steps ahead with the JOY WGO-9

COMPRESSOR

VERTICAL DESIGN—Saves floor space, allows simple installation. Prevents uneven wear in carbon rings. Eliminates necessity for periodic turning of piston to equalize ring wear.

LONG-ROD CONSTRUCTION— Spacer between crankcase and cylinder absolutely prevents passage of oil into cylinder. No part of the piston rod that enters the crankcase can enter the cylinder. No possibility of air contamination.

SECTIONALIZED CARBON RINGS— Expanders maintain ring-contact with cylinder wall despite wear. Rings last longer.

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The patented Dual-Cushion Valves are made of corrosion-resistant materials. In addition, all metallic wearing surfaces are either chrome-plated, surface-hardened, or made of stainless steel.

Free Bulletin A-44 gives details on the Joy WGO-9 Oil-Free Compressor. Write for your copy TODAY to Joy Manufacturing Company, Oliver Building, Pittsburgh 22, Pa. In Canada: Joy Manufacturing Company (Canada) Limited, Galt, Ontario.



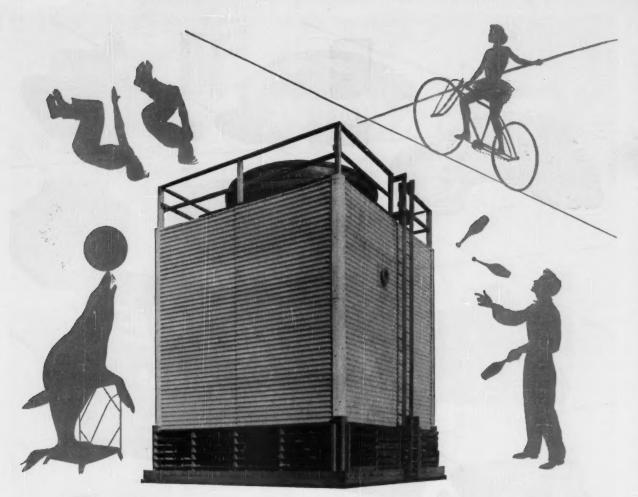


### Consult a Joy Engineer

for VANEAXIAL FANS • COMPRESSORS • OXYGEN GENERATORS
VACUUM PUMPS AND BOOSTERS







## Bolance, too, is important in COOLING TOWERS

In the new CW SERIES COOLING TOWERS Marley engineers have achieved a high performance level that takes these counter-flow towers out of the "conventional" class. A carefully balanced expansion of three major elements results in more cooling ability for every frame size. CW towers offer:

GREATER FILL VOLUME — with more wetted surface in each cubic foot

GREATER AIR VELOCITIES — more pounds of air to pick up heat

GREATER SPRAY BREAK-UP — high pressure down spray on closer centers

There is the correct amount and type of fill to balance the increased air velocity; proper spray pressure to perform adequately with added fill and air flow. Of greatest importance is the skillful integration that makes the expanded features perform at a new low cost per gpm. This balance carries through to the fan, Geareducer, fan cylinder and drive shaft, all Marley designed to function as a unit at higher velocities for longer life.



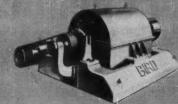
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THE BIRD COAL FILTER



THE BIRD SOLID BOWL CENTRIFUGAL FILTER



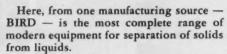
THE BIRD POLISHER

## EEEN

THE BIRD SCREEN CENTRIFUGAL FILTER

## EEENIE WEINIES

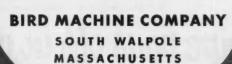
### NO!



But, you don't have to guess or gamble on which one is the most efficient and economical for any given job.

Here, also, is the BIRD RESEARCH AND DEVELOPMENT CENTER, one of the finest laboratories in the world for pilot-scale filtration, clarification, centrifuging or wet classification tests.

This range of equipment combined with complete facilities for determining the best for the job can save you a great deal of time and money. Are you making the most of it?





THE BIRD CONTINUOUS CENTRIFUGAL CLASSIFIER



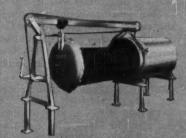
THE BIRD-HUMBOLDT CENTRIFUGAL DRYER



THE BIRD-YOUNG CONTINUOUS

ROTARY VACUUM FILTER

THE BIRD-PRAYON CONTINUOUS ROTARY, HORIZONTAL VACUUM FILTER



THE BIRD PRESSURE FILTER



THE BIRD
SUSPENDED CENTRIFUGAL

### B. F. Goodrich Chemical raw materials



B. F. Goodrich Chemical Company does not manufacture this pipe. We supply only the Geon resin.

### Rigid vinyl pipe pays off in vinegar plant

MANUFACTURING and processing 100-grain vinegar—strong enough to eat holes in steel—means high plant piping and maintenance costs in many food plants. But a manufacturer in Ohio recently showed how to take the bite out of the problem, by piping his vinegar plant with high impact plastic pipe made from Geon resin.

The plant's new rigid vinyl pipe is lighter in weight, less costly, easier to install than conventional pipe . . . shows extreme resistance to vinegar and acetic acid corrosion, inside and

out, even up to 150°F. It is easier to clean and maintain, does not scale, will not deteriorate with aging.

The remarkable physical properties and chemical inertness of Geon have led to this kind of problemsolving in many industries. Geon polyvinyl materials are adaptable, versatile, easy to compound . . . for molding, coating, extruding, spraying, and calendering.

To help you improve an old product or build superiority into a new one, complete information is available from Dept. BB-6, B. F. Goodrich Chemical Company, Rose Building, Cleveland 15, Ohio. Cable address: Goodchemco. In Canada: Kitchener, Ontario.



GEON RESINS • GOOD-RITE PLASTICIZERS... the ideal team to make products easier, better and more saleable.

GEON polyvinyl materials • HYCAR American rubber and latex • GOOD-RITE chemicals and plasticizers • HARMON colors

## Make sure the screw conveyors you buy pass this quality test!

If they don't . . . investigate LINK-BELT's sound engineering and quality manufacture . . . your assurance of top performance

1. Is flighting accurately formed?



Link-Belt's specialized machinery assures accurate forming, producing uniformity of flighting curvature.

2. Are diameters uniform?



Only specially selected steels are used to meet Link-Belt's rigid specifications.

3. Will the hangers match your exact needs?



Hangers are available in gray iron or steel frames in a range of styles and with various bearing materials.

4. Will installation be easy?



Straightness is checked before shipping, and extra care is taken in handling and loading. Jig-drilled coupling bolt holes facilitate assembly.

LINK- BELT

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LINK-BELT COMPANY: Executive Offices, 307 N. Michigan Ave., Chicago 1. To Serve Industry There Are Link-Belt Plants, Sales Offices, Stock Carrying Factory Branch Stores and Distributors in All Principal Cities. Export Office: New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N.S.W.; South Africa, Springs. Representatives Throughout the World.

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Link-Belt's accurate fabrication assures better fit of all components. Choice of metals to fit your need.

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Only Link-Belt builds a complete line of gear and chain drives, couplings, bearings, shafting.

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Discharge spouts and gates can be fixed or detachable. Hand or rack-and-pinion, flat or curved slide gates.

9. Is full ordering information readily available?

Link-Belt's 92-page Screw Conveyor Book 2289 contains complete ordering data. Ask your Link-Belt representative or distributor for your copy today.

## 2 Stock Answers for

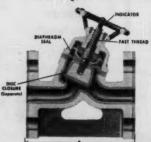


### Famis X-V Series

This versatile, dependable, economicallypriced hand valve is equally at home in
corrosion, abrasion, vacuum or general
service—wherever positive action is
needed. The X-V Series disc—for
positive closure—and diaphragm—
for positive sealing—work independently,
with only the disc exposed to pressure in
the closed position, substantially
increasing diaphragm life, lowering
torque and providing unsurpassed vacuum
service . . . No other valve does such
a complete job at so little cost!

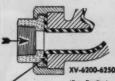
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### DISC for positive closure DIAPHRAGM for positive sealing



#### NEW

Corrosion Resistant Union Ends



#### X-V Series Design Features

- Realistically-Priced for Low-Cost Service
- 50% Greater Capacity than Similar Type Valves
- Only Disc Area Exposed to High Vacuum in Closed Position
- No Packing Gland to Leak.
   Mechanism Not Exposed
- Low Hand-Wheel Torque... Easy to Operate
- Available in Lined or Unlined Models...With Corrosion Resistant Union Ends.

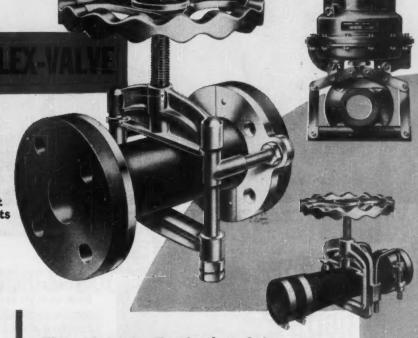
## Tough Valve Problems

### Farris Pinch-type FLEX-VALVE

No other valve controls the flow of hard-to-handle corrosive and abrasive materials with the efficiency and reliability of the Farris Pinch-Type FLEX-VALVE . . . because FLEX-VALVE cannot plug! This is the simplest valve made—only two components—employing the fundamental principle of pinching off the rugged, flexible valve body. Case histories show batteries of these valves in severe service for more than 20 years—and still going strong!

For complete information write for Catalog FL-382

YOUR MONEY BACK IF IT PLUGS!



#### Flex-Valve's Exclusive Advantages

- Will Outwear Any Metal Valve in Abrasive Service
- Full Pipe Capacity
- Maintenance Free
- Bubble Air-Tight
- Low Replacement Cost
- No Obstructions, Pockets or Internal Parts
- Available in Rubber, Neoprene, Butyl, Buna-N, Buna-S, Food Stock and Special Compounds.
- Air or Hand-operated Types



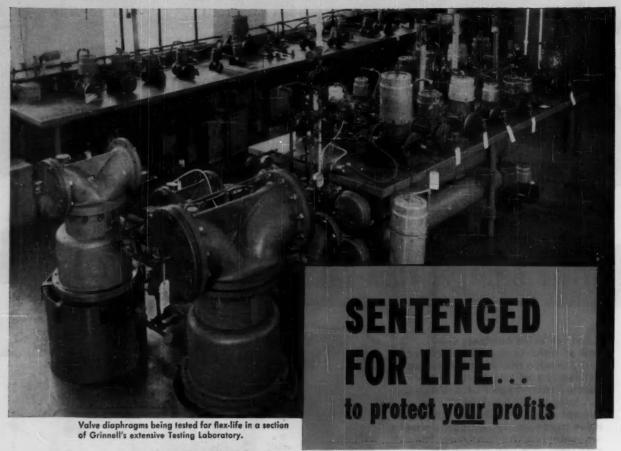
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Rubber mill for mixing experimental diaphragm compounds.





#### Check these important features:

- Diaphragm absolutely isolates working parts from the line fluid.
- Diaphragm lifts high for full, streamline flow in either direction.
- Diaphragm effects positive, leak-tight closure.
- Body, lining and diaphragm materials to suit service.
- Diaphragms easily replaced without removing valve body from line.

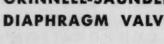
#### **GRINNELL-SAUNDERS** DIAPHRAGM VALVES

#### GRINNELL-SAUNDERS DIAPHRAGM VALVES

have won an envied reputation for long, trouble-free service under the toughest operating conditions. One reason is Grinnell's continuous test program. In this life-test laboratory, valves and diaphragms operate day and night, through thousands of opening and closing cycles, to pre-prove performance. Result - better valves for all types of services.

This program of continuous testing is the basic reason why so many different industries are turning to Grinnell-Saunders for diaphragm valves with preproved performance. There are standard types for a wide variety of applications . . . in the handling of corrosive liquids, gases, beverages, compressed air, fluids loaded with suspended solids - on lines where leakage, corrosion, clogging, abrasion, or contamination could be costly.

Are your valves giving you the dependable, long service life you must get to maintain economy and efficiency? If they are not, it will certainly pay you to consult a Grinnell engineer.

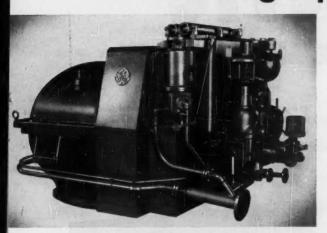


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Grinnell Company, Inc., Providence, Rhode Island pipe and tube fittings \* welding fittings \* engineered pipe hangers and supports \* Thermolier unit heaters \* valves Grinnell-Saunders diaphragm valves • pipe • prefabricated piping • plumbing and heating specialties • water works supplies Grinnell automatic sprinkler fire protection systems Amco air conditioning systems industrial supplies



## How G-E Engineers Locate "Quiet Zones" for Safer High-speed Turbine Operation



TYPE DRV HIGH-SPEED MECHANICAL-DRIVE TURBINE

When driving modern compressors and blowers, G-E high-speed turbines spin at operating speeds of 7000 rpm and up. At such speeds, if resonant vibration were not controlled carefully, bucket fatigue failure might result.

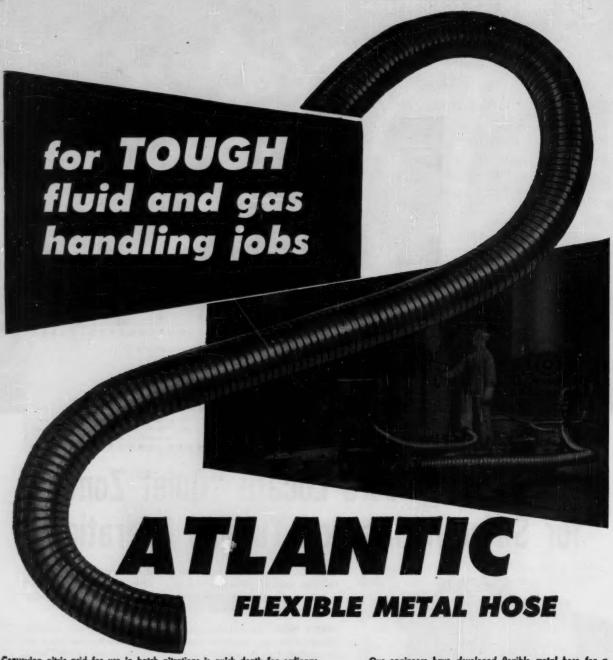
HERE'S HOW General Electric combats the problem: Natural vibration frequencies of the buckets on each new turbine rotor are determined with the special equipment shown above—an oscillator, crystal pick-up, and high-speed level recorder. "Quiet zones" of minimum normal vibration are clearly revealed.

With this information available, the number of nozzles can be varied so that steam striking the buckets will create vibration-exciting frequencies only in these "quiet zones." By thus making sure that steam-impact frequencies don't coincide with critical natural frequencies, the chance of bucket failure is greatly reduced.

VIBRATION TESTING is one of many features that add to the reliability of G-E high-speed turbines. For more information, contact your nearest G-E Apparatus Sales Office or write General Electric Company, Schenectady 5, N. Y.

Progress Is Our Most Important Product

GENERAL EB ELECTRIC



Conveying nitric acid for use in batch nitrations is quick death for ordinary Rexible metal hase. Sulphuric acid and plating solutions are other notorious killers. When temperature and pressure extremes and adverse handling conditions are also involved, hose replacement is frequent and expensive.

That's why-for tough jobs-it's good economy to specify Atlantic flexible metal process hase. Manufactured to survive the most destructive use, it is unequalled for leak-proof qualities, flexibility, durability, strength and lightness. It performs long after ordinary have is scrapped and returns real savings in yeur material and labor dollar.

Whatever your application - conveying, controlling movement and vibration, correcting misalignments, compensating for expansion and contraction - there Is an Atlantic flexible metal hase that is best for it.

Available in Seamless or Interlocking construction: Steel, stainless steel, monel, bronze. 14"-36" I.D. Inclusive with appropriate fittings.

Our engineers have developed flexible metal hose for a number of classified nuclear applications. Though these types cannot be released at present, the experience gained is available for any unusual problems you may have.

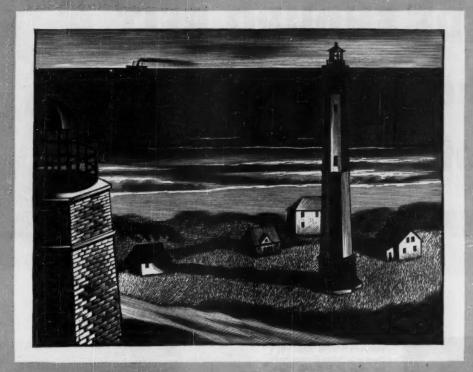
Write for Chemical and Process Industries Bulletin 200.

See our Catalogs

in Sweet's Files for Product Designers and Mechanical Industries.

ATLANTIC

ATLANTIC METAL HOSE CO., INC. 329 Dyckman St., New York 34, N. Y.

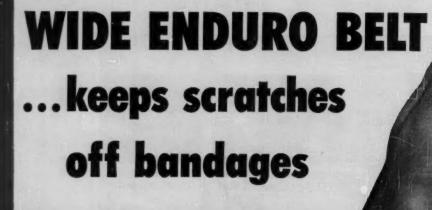


CAPE HENRY LIGHT, located on the south side of the entrance to Chesapeake Bay, was the first lighthouse to be built by the United States. The octagonal tower of sandstone, 129 feet high, was constructed of materials gathered while Virginia was still a colony. This original structure still stands, though it was damaged during the Civil War and is no longer in use. It was replaced in 1881 by the present lighthouse, a cast iron tower 167 feet high, located 337 feet to the northeast.

Pointing the way to progress in the development and use of electrochemicals is the pioneering research of Niagara Alkali Company. Niagara was the first in the country to produce several of these important materials and through research is constantly improving the usefulness of Nialk® Liquid Chlorine, Nialk Caustic Potash, Nialk Carbonate of Potash, Nialk Caustic Soda, Nialk Paradichlorobenzene, Nialk TRICHLORethylene, Niagathal® (Tetrachloro Phthalic Anhydride).

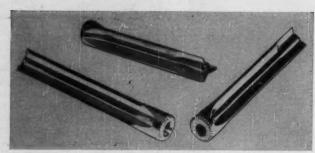
#### NIAGARA ALKALI COMPANY

60 East 42nd Street, New York 17, N.Y.





CORROSION RESISTANCE IN TUBULAR FORM. Republic's Steel and Tubes Division turns out miles of ENDURO Stainless Steel Tubing for the process industries and for mechanical applications. Repub-lic ELECTRUNITE Stainless Steel Tubing and Pipe offer the identical high mechanical and corrosion-resisting properties demonstrated in sheet form by the Reynolon belt. Call Steel and Tubes for applica-tion assistance on all your fluid handling and tubing problems.



WHAT'S EVEN MORE CORROSION-RESISTANT? REPUBLIC TITANIUM. Titanium surpasses even stainless steel in resistance to many severe forms of corrosion. Yet, it weighs only 56% as much as alloy steel. Here, Republic Titanium supplies corrosion-resistance and lighter weight to parts designed to knit human bones. Republic Titanium and Titanium alloys now are available for civilian applications. Republic has the experience to help you use them best. Write us.



#### REPUBLIC STEEL CORPORATION 3116 East 45th Street, Cleveland 27, Ohio

I'm interested in additional information on:

- ☐ Republic ENDURO® Stainless Steel
- ☐ Stainless Metallurgical Assistance
- ☐ ELECTRUNITE® Stainless Steel Tubing
- ☐ Republic Titanium

Republic Steel Drums

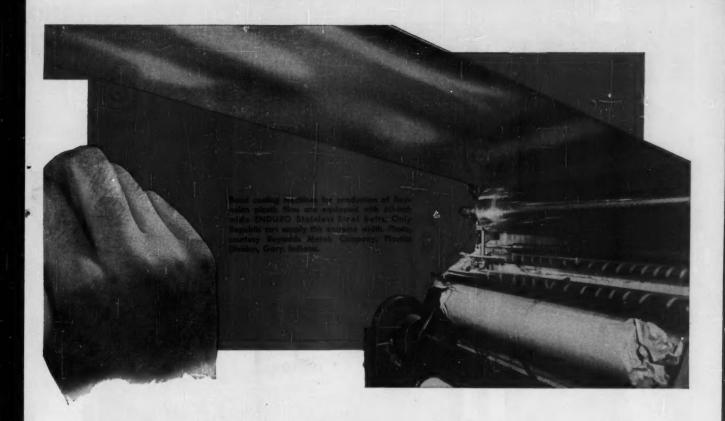
Company\_

Address.

Zone\_State

NO CONTAMINATION—NO SPOILAGE. Republic Steel offers a full range of barrels, drums and pails in a variety of metals and finishes to protect your chemical, food and other products. Choose from ENDURO Stainless Steel, hot dipped galvanized steel, hot dipped sheet steel, hot rolled open hearth steel, plain or lacquer lined. Choice of gages to meet all handling and shipping requirements. Many styles in sizes up to 55 gallons. Con-tact Republic.





This wide, polished ENDURO Stainless Steel belt carries Reynolon plastic coatings in process. One such type makes the peel-off backing for those handy packaged small bandages you use.

The ENDURO surface provides a high luster finish! Since the slightest scratch would be "mirrored" or duplicated in the finished product, the quality of the stainless steel surface determines the quality of the plastic coating. Here, ENDURO keeps scratches off bandages!

Note that the belt is supported only by top rollers. That allows both sides to carry the plastic material... speeds production. It also means that the belt must have great tensile strength. ENDURO supplies that strength. In this case, tension on the belt runs as high as 90 tons.

What's more, this belt must be heat-resistant. In process, material passes through 600° ovens. And, many of the plastics processed are in hydrous or acidic solutions. So, the belt must resist rust and corrosion. ENDURO does just that.

Four of these sixty-inch wide belts help produce Reynolon plastic film. Even at this extreme width, the belts must stay flat. "Crowned" metal could snap like an oil can and damage the plastic.

Republic metallurgists worked closely with Reynolds Metals Company, Plastics Division, to develop this unusual equipment. If you have process or product problems involving heat, corrosion, surface finish or strength, ENDURO Stainless Steel quite likely is your answer. Republic metallurgists will help you apply it most profitably. Write Republic.

#### REPUBLIC STEEL

World's Widest Range of Standard Steels and Steel Products

"We were fed up with replacing piping every 2 or 3 months, so we put in U.S.
Uscolite Pipe 2 years ago—and haven't replaced a length yet!"

says manager of a midwest chemical plant

A chemical plant in Illinois makes sodium hypochlorite, for use in bleaches, laundry disinfectants, water purifiers. Until over 2 years ago, the piping that carried the chlorine and hypochlorite would fail every 2 or 3 months. This was considered a routine performance—until U.S. Uscolite® plastic pipe was installed. Uscolite has now been on the job for over 2 years and shows no sign of deterioration and we have eliminated our troubles with metallic contamination!

Another big point about Uscolite, says the factory manager, is that a part of the pipe is exposed year after year to the weather on an outside truck loading station. Any damage? "No, none whatever."

Uscolite is a product of United States Rubber Company. This great plastic is available not only in piping, but in pipe fittings, valves, and sheet stock for fume ducts. Uscolite is extremely light in weight, yet has very high impact strength. It resists acids, salts, alkalies, fumes—inside and out.

View of U.S. Uscolite Pipe carrying bleach on outside truck loading station. Years of exposure to every kind of weather have had no effect on this piping. (Right) Uscolite pipe carrying bleach to storage tank.

Rid yourself of piping problems. Next time you require new piping, or replacement of old piping, remember Uscolite. Call any of the 27 "U. S." District Sales Offices or write address below.

Uscolite pipe and fittings are made in the broadest and largest line of stock sizes of plastic pipe on the market. Sizes follow:

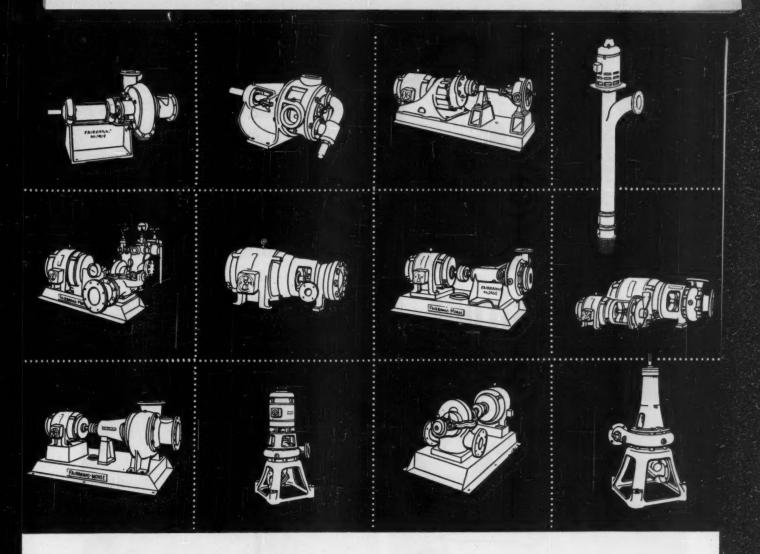
Molded fittings in ½" through 4" I.P.S. ● Molded flanges ½" to 6" I.P.S. ● ½" to 3" Uscolite diaphragm valve (Hills-McCanna). ● Header pipes in 2", 3", 4", 6" pipe sizes. ● Pipe in standard wall dimensions and extra heavy wall dimensions in ½" through 6" pipe sizes.



"U.S." Research perfects it . . . "U.S." Production builds it . . . U.S. Industry depends on it.

UNITED STATES RUBBER COMPANY MECHANICAL GOODS DIVISION . ROCKEFELLER CENTER, NEW YORK 20, N. Y.

Hose • Belting • Expansion Joints • Rubber-to-metal Products • Oil Field Specialties • Plastic Pipe and Fittings • Grinding Wheels • Packings • Tapes Molded and Extruded Rubber and Plastic Products • Protective Linings and Coatings • Conductive Rubber • Adhesives • Roll Coverings • Mats and Matting



#### YOU CAN RELY ON YOUR FM PUMP ENGINEER...

#### to solve any pump problems!

Troubled by a pumping problem? There's an easy solution. Call your Fairbanks-Morse Field Engineer. His business is solving your problems... selection and applying pumps that will answer your needs most economically and efficiently.

Because Fairbanks-Morse is the world's largest manufacturer of a complete pump line, your Fairbanks-Morse

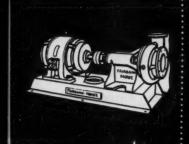
Field Engineer is not handicapped in his recommendations. He can select the pumps that offer you the most for your pump dollar. He has the field experience and is backed by the most experienced pump engineering department in the business. To solve your pump problems, call your Fairbanks-Morse Field Engineer. Fairbanks, Morse & Co., Pump Division, 3601 Kansas Ave., Kansas City, Kansas.



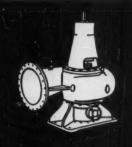
#### FAIRBANKS-MORSE

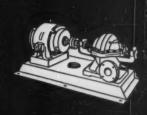
a name worth remembering when you want the best

PUMPS . SCALES . DIESEL LOCOMOTIVES AND ENGINES . ELECTRICAL MACHINERY . RAIL CARS . HOME WATER SERVICE EQUIPMENT . MOWERS . MAGNETOS



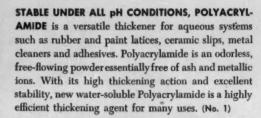






# Life... the Chemical

on the Chemical Newsfront



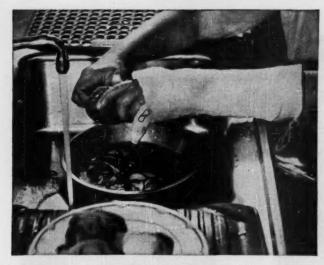


#### BETTER COLOR FASTNESS IN RESIN-TREATED FAB-

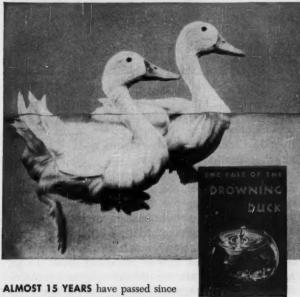
RICS now is possible with Cyanamid's line of Calcodure Resin Fast Dyes. Unlike ordinary dyes, which are adversely affected when fabrics are resin treated for softness, wrinkle resistance and other qualities, Calcodur Resin Fast Dyes actually improve in color fastness after treatment. Also, they offer ease of application to various types of fabrics containing cellulosic fibers either alone or in blends. (No. 2)



June 1955—CHEMICAL ENGINEERING



LIGHTWEIGHT CASTS FOR FRACTURE PATIENTS now are being prepared from a new cast material made from plastic resin and plaster of Paris. The new casts are lighter and thinner than ordinary casts, but provide four times the wet strength and twice the dry strength of materials used previously. As a result, they are more comfortable and less fatiguing, they encourage earlier mobilization, and permit clearer X-ray examination. Developed by Davis & Geck, Inc., a unit of Cyanamid, these casts are washable as well as water, perspiration-, and urine-resistant. Doctors prepare the new casts quickly by merely wetting with water. (No. 3)



ALMOST 15 YEARS have passed since Cyanamid's famous ducks first appeared. Because this illustration ex-

plained wetting power so graphically, it was featured by the press and newsreels. In 1942, Erle Stanley Gardner made it the theme of his Perry Mason mystery, "The Case of the Drowning Duck." For 15 years, while our two ducks continued to mean wetting power to millions, industry has found use for Aerosol® Surface Active Agents in thousands of processes and a progression of new uses. Among these uses are crystal growth modification, leak-testing tanks used to store liquids of lower surface tension than water, powerful new dry-cleaning detergents, and wallpaper removers. These and many other important applications are highlighted in our new booklet on Aerosol Surface Active Agents. (No. 4)

News Briefs

outstanding performance in surface coatings is being reported for the new XA Polyester Coating Resins. Similar in composition to the unique polyester/glass-fiber plastics, XA Polyester Coating Resins are solutions in a reactive monomer such as styrene. Properly catalyzed, they cure to insoluble, infusible films in a few hours at room temperature. Since they cure without loss of volatile material or liberation of water, they can be applied in films up to 10 mils thick. Thick films reduce labor of finishing porous materials such as wood, fiberboard and masonry. XA Polyester Coating Resins also exhibit excellent resistance to chemicals, solvents and water. Since this type of polyester resin is a new development for the paint industry, only experimental samples are available at present. (No. 5)

CRUMBLED BATCHES OF OIL-EXTENDED GR-5 STOCKS can be avoided by using Pepton® 22 catalytic plasticizer for GR-S and natural rubber. Pepton 22 also improves processing of stocks by reduction of viscosity during mastication. This means faster breakdown time, lower power consumption and reduced processing cost. The peptizing action of Pepton 22 during hot mastication demonstrates its efficiency as a catalytic plasticizer. (No. 6)

BLACKHEAD DISEASE IN TURKEYS now is controlled more economically with new Enheptin®-A 2-acetylamino-5-nitrothiazole. The new drug is more effective than the former ENHEPTIN® 2-amino-5-nitrothiazole. Extensive research among many groups of chemical compounds did not reveal a better drug than ENHEPTIN but its acetyl derivative, ENHEPTIN-A, was found to be more effective so that lower dosage may be used. The drug is supplied to feed manufacturers for proper distribution in feed, and is available to turkey raisers as medicated feed. It may be used at specified levels as a disease preventive, or at higher levels as a control after an outbreak occurs. Extensive tests have shown that the drug has no effect on breeding activity or egg production, and medicated birds grow and maintain body weight equal to unmedicated birds. Devastating blackhead disease no longer means disaster for turkey raisers; Enheptin-A in medicated feeds controls it economically. (No. 7) \*Trade-mark



#### ECONOMY

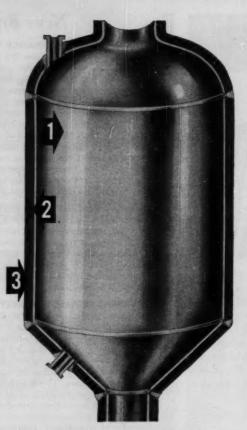
High-alloy layer—usually 10% or 20% of total plate thickness—assures corrosion and abrasion resistance, long equipment life.

#### DESIGN FREEDOM

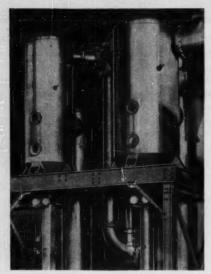
Integral bond allows design and fabrication of shapes to meet process and space needs.

#### STRUCTURAL STABILITY

Low-cost carbon steel backing provides necessary strength and rigidity.



Nickel-clad steel in this double effect evaporator guards against product contamination.



**CLAD STEEL EQUIPMENT PERMITS** 

#### **FULL DESIGN FREEDOM**

For pressure, vacuum or cyclical service, economical clad steels give you maximum freedom of design in tanks and pressure vessels. Clad steels are readily worked by conventional fabricating tools and methods, can be formed to shapes that best suit space and process needs. Because of the integral bond between high-alloy cladding and the carbon steel backing plate, full gage consideration is permissible under the ASME Code. You're assured of extralong service life, too, since openings can be cut and attachments welded to clad steel without harming this bond or allowing seepage.

By using clad steels, you get all the advantages of solid, high-alloy construction—protection from corrosion, abrasion and product contamination—with savings up to 50%

in material costs. These and other benefits, like fast heatup, easier cleaning and low maintenance, can be obtained from 16 cladding materials—various types of stainless, nickel, Inconel, Monel, copper.

These are supplied with a standard sodium hydride finish, or may be polished to help improve performance characteristics. When you're thinking of new tanks and vessels, qualified equipment builders can help your engineers and consultants take advantage of versatile Lukens' Clad Steels. We work closely with fabricators to help select the type most suited to your processing needs. To get more information, ask one of your equipment builders, or write Manager, Marketing Service, Lukens Steel Company, 749 Lukens Building, Coatesville, Pennsylvania.

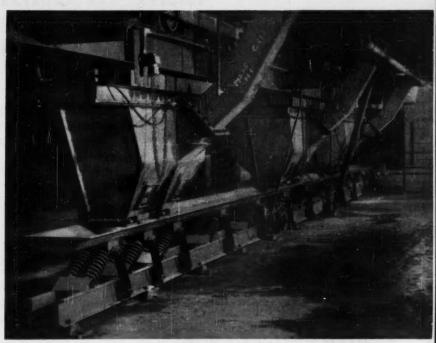


#### KENS CLAD STEELS

STAINLESS-CLAD · NICKEL-CLAD · INCONEL-CLAD · MONEL-CLAD

PRODUCER OF THE WIDEST RANGE OF TYPES AND SIZES OF CLAD STEEL PLATES AND HEADS AVAILABLE

## HOW TOUGH CAN CONVEYING GET?



A 55' Carrier Heavy Duty Conveyor. Capacity: 20 tons-per-hour of hot sintered coke. One 5 HP drive.

Check this list . . . see if you know of a material that is harder to handle than any of these.

ROCKET FUEL POWDER
HOT CEMENT CLINKER
FLY ASH
DRIED SEWAGE SLUDGE
COKE BREEZE
DRY CALCIUM CARBIDE
TITANIUM DIOXIDE
WET SUGAR
SILICON-CARBIDE
MACHINE TURNINGS
SINTERED ORE
SLAG
CORROSIVE CHEMICALS
FRAGILE CRYSTALS

THE materials at right, above, have one thing in common: they are all being conveyed efficiently and economically with Carrier Natural-Frequency Conveyors.

Here's why plants processing these materials turned naturally to Carrier Natural-Frequency:

A lot of the materials had proved too sharp or oily for belt or flight conveyors. Others were so sticky they made screw conveyor cleaning a maintenance nightmare. Still others were too abrasive for apron and conventional vibrating conveyors. Some were subject to spillage in any ordinary conveyors.

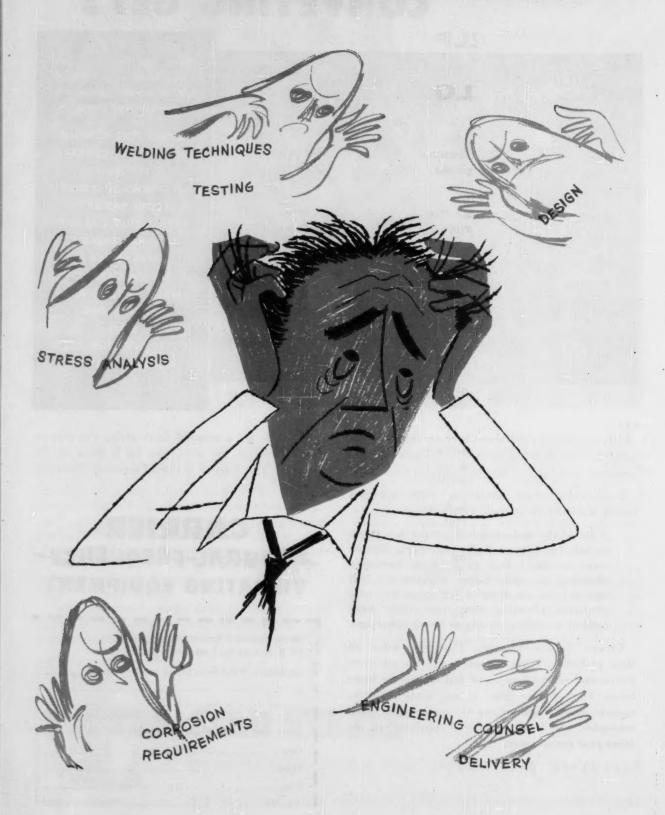
Carrier Natural-Frequency Conveyors solve all these problems. These amazing conveyors substitute the natural resonant action of coil springs for brute force. They require little, if any, more power to operate, empty, than to run the motor alone. And remember, the lower the power requirements, the lower your maintenance.

If you've got a material that's giving you conveying troubles of any kind, just jot it down on the coupon. The Carrier Natural-Frequency Conveyor may solve yours.

## CARRIER NATURAL-FREQUENCY VIBRATING EQUIPMENT

	nveyor Corporation son St., Louisville 6, Kentucky
Gentlemen:	We've been having trouble with
	Without obligation
please send	Carrier Natural-Frequency Bulletin No. 111
Firm	
Street	
City	State
Att: Mr.	Dept

## WHEN YOU'RE UNDER PRESSURE ON PRESSURE VESSELS...



# THIS IS THE KIND OF HELP YOU GET AT KELLOGG...

**Design Engineering:** Kellogg will assume entire responsibility or work closely with your own design engineers on their proposals. Optimum designs are assured either way.

**Technical Competence:** Kellogg's experience in metallurgy, heat transfer, stress analysis, metal fatigue, corrosion control, is unequalled among pressure vessel fabricators.

**Fabricating Techniques:** Kellogg fabrication methods are the culmination of 40 years of building pressure vessels to exacting specifications. Many improved techniques have resulted, such as K-Weld\*.

**Non-Destructive Testing:** Kellogg's complete facilities include the company's portable "atomic cameras" which can photograph welded seams up to six inches thick in a single short exposure.

**Prompt Delivery:** Kellogg's plant modernization program assures faster delivery than ever before. Small and large orders receive the same attention.

**Construction Service:** Kellogg's continuing work in erecting vessels for complete oil refineries, pulp mills, and chemical plants provides a fully-staffed construction department with crews that know their jobs.

**Guaranteed Performance:** Kellogg's reputation has been built on long and efficient product life. The MWK name plate is your guarantee.

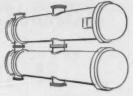
#### FABRICATED PRODUCTS DIVISION THE M. W. KELLOGG COMPANY, 225 BROADWAY, NEW YORK 7, N. Y.

In Canada: The Canadian Kellogg Company, Limited, Toronto In Europe: Kellogg International Corporation, London SUBSIDIARIES OF PULLMAN INCORPORATED

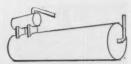
\*Trademark of The M. W. Kellogg Company

#### PUT YOUR PROBLEMS UP TO





HEAT TRANSFER EQUIPMENT



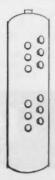
TANKS AND REACTORS



KNOCKDOWN VESSELS



PROCESS



PRESSURE VESSELS







## like Buckeye Cellulose does with ATRVEYOR.

Once again, the Airveyor goes into service in the pulp and paper industry—this time in the 25 million dollar plant of the Buckeye Cellulose Corporation, Foley, Florida, subsidiary of the Procter & Gamble Company. This thoroughly modern plant has a capacity of 300 tons of dissolving cellulose pulp per day.

Incoming mill-supply chemicals are handled by two Airveyor conveying systems. One system unloads salt cake from box cars and delivers to a storage bin at rate of 10 tons an hour. The same system also conveys from a pulverizer discharge and delivers to a service bin in the recovery building. The second Airveyor unloads alum and pebble lime from either box or hopper-bottom cars and delivers to a storage bin at rate of eight tons an hour.

The pulp and paper industry has learned by experience that Fuller Company is able to engineer and build equipment that will serve them for many years, at the lowest operating and maintenance cost. This is attested to by the many satisfactory installations in operation. Individual company purchases range from one to as many as twelve systems.

You should get all of the facts on the Airveyor. This specialized system, developed by Fuller, with many years of experience in conveying with air, can save you many a dollar, day in and day out. Why not have a Fuller engineer make a study of your conveying problems—it will cost you nothing.



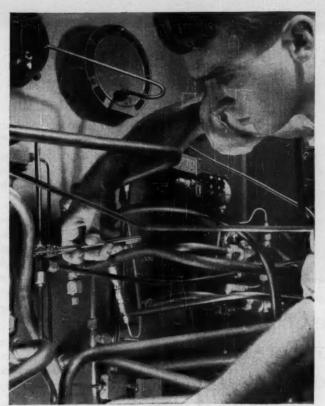
Fuller
... pioneers in harnessing AIR

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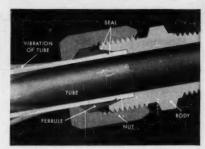
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DRY MATERIAL CONVEYING SYSTEMS AND COOLERS . . . . PREHEATERS . . . . COMPRESSORS AND VACUUM PUMPS . . . . FEEDERS



### "Tube up and forget it" with leakproof Parker fittings

Triple-lok flore fittings are the easiest, fastest and safest way to tube up even in close quarters. They are absolutely leakproof even under the severest conditions of vibration, high pressures and temperatures. Triple-lok fittings meet J.I.C. and S.A.E. Standards plus specifications of the A.S.M.E. Code for Pressure Piping. Available for tubing outside diameters from ½ through 2 inches. More Triple-lok fittings are used on industrial machinery than any other fittings.



Ferulok flureless fittings, featuring the visible "bite", are especially for high-pressure, heavy-wall tubing. Cutaway shows why vibration won't break the seal.



New Hoze-lok fittings and hose assemblies (for medium and high-pressure hydraulic service) offer better performance, easier make-up, greater re-usability.



New Weld-lok fittings are machined from high-quality steel or stainless-steel bar stock and forgings. They are available for tubing 1/4 through 2 inches, O.D.



New Intru-lok tube fittings can be quickly installed by anyone. Simply push tube in, then tighten nut. Designed for instrumentation lines of 1/4 through 1/2 inch, O.D.



Other Parker products include new hydraulic control valves, check valves, accumulators and O-rings. Mail the coupon for the fitting catalogs you want,



Parker

Hydraulic and fluid system components

# for your information...

brief summaries of helpful product news

#### Production Men: Protective Coatings, Made Tougher With Aroclors, Cut Maintenance Costs

Production men are discovering that maintenance costs nose-dive when Aroclors,\* Monsanto's chlorinated biphenyl and chlorinated polyphenyls, are used as plasticizers and resins for chlorinated rubber and high styrene-butadiene base paints.

These tough, modern coatings armor metal, brick, stone, and concrete against acid fumes, alkalies, and gases in chemical plants, paper mills, textile mills, petroleum refineries, and many other plants.

In exterior applications, "rubber base" coatings protect tank cars and construction machinery against corrosive materials and weather extremes. Aroclor-based maintenance paints are readily available from the country's leading paint manufacturers. For more information about Aroclors generally and their many diversified applications, check the coupon and let us send you "The Aroclors," O-P-115.

#### Mersize RM Dry Improves Paper Sizing Efficiency

Leading paper manufacturers report that this complete fortified size has greatly improved their over-all operation.

They particularly cite these Mersize\* RM Dry benefits:

- Less dust. Beater room men like Mersize RM Dry because it's low in dusting, less irritating, not so sticky to handle.
- High efficiency. Against dry rosin size, Mersize gives equal sizing with

40% less material. Outperforms other dry fortified sizes—dollar savings up to 15%.

- Light color. Mersize doesn't darken with age... produces highbrightness paper equal to lightest rosin size.
- Low foam index. Produces less foam than any other size—fortified or rosin! Smooths out production problems.

For complete information on Mersize RM Dry, mail coupon at right.

#### Actamer soap antiseptic helps reduce employe absenteeism

By keeping your washrooms stocked with soap containing Actamer,\* Monsanto's soap bacteriostat, you can help keep employes on the job by reducing the infections which often follow skin injuries.

Control of skin bacteria is important because 60% of all occupational disease compensation cases are based on skin disorders and resulting infections. Regular use of soap containing Actamer reduces bacteria up to 97%, thus cutting the chances of skin infections.

Industrial soaps with Actamer are available in bar, liquid or powder forms. For a list of suppliers, check the coupon at right and mail it to Monsanto today.



#### New Adipic Acid bulletin features literature survey

A new 36-page technical bulletin on adipic acid has just been published by Monsanto. Highlight of the bulletin is the extensive literature survey it contains. More than 80 patent and literature references describing numerous products are summarized. Other sections discuss the properties, toxicity and general chemistry of this versatile compound.

The bulletin was written primarily for research chemists and manufacturers interested in using adipic acid to make a variety of coating, molding and spinning resins and

Plasticizers Surfactants Adhesives Waxes Paper finishes
Insect repellents
Textile chemicals
Lubricants, etc.

Resins made with adipic acid have an inherent flexibility which bypasses the need to plasticize harder resins. One advantage is increased durability of finished products. Adipic acid has long been used to make nylon.

Other interesting applications are elastomers and isocyanate-foamed polyesters from adipic acid. These possess amazing durability and are used as rubber substitutes, insulating, soundproofing, upholstery, cleaning and other materials.

Send the handy coupon for your copy of Tech. Bulletin O-105.



#### Versatility of Dibutyl Fumarate described in new technical bulletin

A new technical bulletin is now available on versatile dibutyl fumarate. A reactive resin and chemical intermediate, dibutyl fumarate forms copolymers with various monomers under adjusted reaction conditions to produce polymers ranging from brittle resins to soft, internally plasticized materials.

Copolymers of dibutyl fumarate with vinyl acetate, vinyl chloride, acrylates and styrene are used in formulating surface coatings, free films, permanently tacky adhesives, fibers, synthetic lubricants and addition agents for oils. And as a chemical intermediate, it yields substituted succinates readily with the addition of halogens, aldehydes, thiols and similar compounds.

For your copy of the new bulletin, just check the coupon at right and mail it to Monsanto today.

#### New film, "Before Hydraulic Fires Start," available for showing

A new 12-minute motion picture, "Before Hydraulic Fires Start," demonstrates how Monsanto's Pydraul\* F-9 fire-resistant hydraulic fluid protects your plant and employes from costly hydraulic line fires.

Filmed in die-casting and steel plants using hydraulic power near a source of intense heat, the movie stresses how Pydraul F-9 makes possible the increased use of hydraulics where the danger of fire exists.

You will see tests proving that Pydraul F-9 outperforms other hydraulic fluids for lubricity, compressibility, pour point...how it prevents costly corrosion, oxidation...how its solvent action prevents build-up of sludge and impurities.

In addition to showing how easy it is to change over to Pydraul, the movie also illustrates, step by step, how easily and economically Pydraul F-9 can be reclaimed and re-used to sharply reduce new fluid requirements.

Prints of the 12-minute 16-mm, black-and-white sound movie are available from Monsanto.



#### Salicylic Acid Crystals now easier to handle

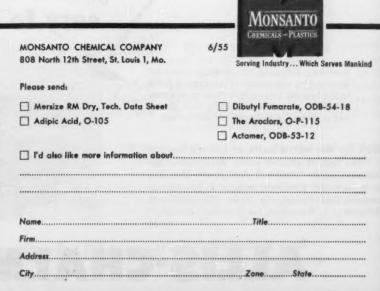
Monsanto's new and improved Sublimed Salicylic Acid Crystals feature shorter, broken needle structure and are offered in easy-tohandle standard containers. The improved material flows freely, eliminates "packing."

Want more information? Note your request below.

#### DIDP-E offers big wire coatings benefits

For maximum retention of elongation, tensile strength and modulus properties in wire coatings, specify Monsanto plasticizer DIDP-E (with 0.1% Bis Phenol A antioxidant added). Tests show that the compound's electrical properties are equal or superior to DOP. 60° C. T or TW formulations are now available.

\*Reg. U. S. Pat. Off.



# Set Soth bearing features



fully enclosed and protected

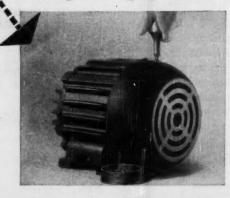
The bearing cap is held tightly in place against the inner face of the bearing enclosure. This cap, with its close running clearances, keeps grease from the interior of the motor . . . retains an ample supply within the bearing enclosure.

At the outer side of the bearing, double labyrinth seals keep grease in, also keep dirt out. What's more, large grease reservoirs act as additional dirt traps.

easy to grease

You can lubricate the bearings without dismantling the motor. Pipe-tapped holes in the bearing housings at three points provide both means for inserting new grease and a means of flushing out old grease.

Look for the extra bolts on the end housing , the sign of greater value. Ask your Allis-Chalmers representative or Authorized Distributor to show you a cutaway section of this maintenance-cutting design. Or write Allis-Chalmers, Milwaukee 1, Wisconsin, for Bulletin 51B7225.

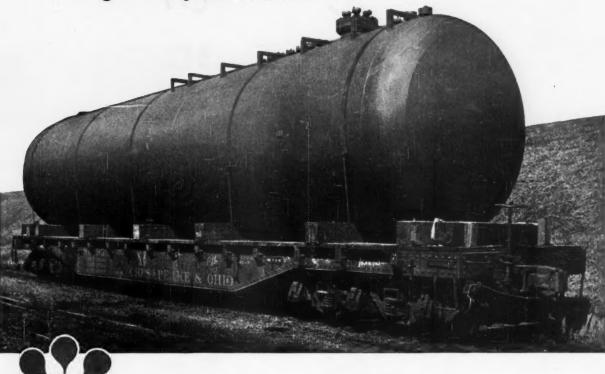


**ALLIS-CHAL** 





One of six 51-foot liquid chlorine horizontal storage tanks built and tested by Newport News to meet A.S.M.E. Code requirements. This pressure vessel was welded by Union melt machines. Pressure vessels undergo stressrelieving treatment in our ovens.



### Large Units single or multiple

Built with careful attention to detail by specialists in Metal Fabrication

Whether specified in alloyed or carbon steel, stainless, high nickel alloys or clad ... you'll find it pays to have Newport News fabricate your large units.

Avail yourself of the specialized production techniques, and the skill of Newport News craftsmen operating vast steel fabricating shops.

Units of large dimension are readily constructed by Newport News in a 225acre plant that includes five huge, fully equipped machine shops, drop forging and die facilities, heat treating ovens, and acres of brass, iron and steel foundries.

Moreover, modern testing apparatus, used for thorough investigation of materials and techniques, contributes to the excellence of Newport News fabrication. In addition, Newport News shop erection of fabricated units assures trouble-free assembly at your plant site.

Let us bid on your present or future projects. If you are not familiar with the way Newport News can help you, write for our booklet entitled "Facilities and Products"... it's yours for the asking.



Newport News Shipbuilding and Dry Dock Company

Newport News, Virginia

## Depend on LADISE

**Carbon Steels** 

Carbon-Molybdenum Steels

Chromium-Molybdenum Steels

Nickel Steels

**Chromium-Nickel Steels** 

Chromium-Silicon-Molybdenum

Wrought Iron

**Chromium Type Stainless** 

**Chromium-Nickel Stainless** 

Molybdenum Type Stainless

Wrought Aluminum

**Aluminum-Copper Alloys** 



**BUTT WELDING FITTINGS** 

1/2 inch through 42 inches ...



FORGED CORROSION RESISTANT—LIGHT WEIGHT and A.S.A. FLANGES

1/2 inch through 24 inches . . .



FORGED SCREWED OR SOCKET WELDING FITTINGS and UNIONS

1/8 inch through 4 inches...



LARGE DIAMETER AND T.E.M.A.\*
STANDARD FLANGES up to 20 feet O.D.

LONG WELDING NECKS
up to 24 inches, 150 lb. through 2500 lb.

\*Tubular Exchanger Manufacturers Association

# Complete Service ...



**BUTT WELDING FITTINGS** 

Schedules 55, 105, 405, 805, and other Schedules and wall thickness.

0 9 0 9 0

FORGED CORROSION RESISTANT—LIGHT WEIGHT and A.S.A. FLANGES
150 lb. through 2500 lb. pressure ratings.



FORGED SCREWED OR SOCKET WELDING FITTINGS and UNIONS 150 lb. Corrosion Resistant and 2000 lb. through 6000 lb. ratings.

# FOR FITTINGS FROM ANY FORGEABLE MATERIAL TO MEET YOUR SERVICE REQUIREMENTS

You get prompt, efficient service when you specify and order from the complete Ladish Controlled Quality line. Fittings in any forgeable material in virtually every type, size, wall thickness or pressure rating ... are produced to one uncompromising Controlled Quality standard ... and identified with heat code symbols pioneered by Ladish as verification of metallurgical integrity resulting from exhaustive tests made in the Ladish metallurgical laboratories.

For complete service on your fittings requirements, depend on the Ladish line and the services of your Authorized Ladish Distributor.

THE COMPLETE Controlled Quality FITTINGS LINE

LADISH CO.

CUDAHY, WISCONSIN

District Offices: New York • Buffolo • Pittsburgh • Philadelphia • Cleveland Chicago • St. Paul • St. Louis • Affanta • Houston • Odessa • Tulsa Las Angeles • San Francisca • Seattle • Havana • Mexico City • Brantford, Ont.



Aluminum-Manganese Alloys

Deoxidized Copper

Hastelloy

Titanium

Forging Brass

**Everdur Bronze** 

Silicon Bronze

Manganese Bronze

Wrought Nickel

Nickel-Copper Alloys

Inconel

Monel

# buell dust recovery really pays off, too!

**BUELL ENGINEERS** help you to get greater "returns" from your valuable industrial dusts because they deal in FACTS! Important, too, they give you *all* the facts before your company invests a cent.

**WITHOUT OBLIGATION...** Buell Engineers submit samples of your valuable dust to their laboratory for analysis... make a thorough, on-the-spot study of your operations!

**THEY RECOMMEND** from the complete line of Buell Dust Recovery Equipment the unit, or combination of units... that is most suitable for your operating conditions.

BUELL "SF" ELECTRIC PRECIPITATOR with its exclusive "Spiralectrodes" and continuous cycle rapping! Buell Cyclone Collector with its exclusive "shave-off" design! Buell PMV Non-Returning Hopper Valves with their positive sealing and self-cleaning features! These are just some of the reasons why Buell Engineers can offer you the ultimate in valuable dust recovery.

**THEY TELL YOU EXACTLY HOW MUCH** valuable dust can be recovered from your operation... before you become obligated in any way!

WHY WAIT? With "profits" to gain...nothing to lose...why not take advantage of this generous proposition right away?

**WRITE TODAY** for free booklet: The Collection and Recovery of Industrial Dusts—which clearly explains *all three* Buell Systems. Dept. 12-F, Buell Engineering Company, 70 Pine Street, New York 5, N. Y.







Results Bring Re-Order from Heyden Chemical Corp. for Second Kemp Inert Gas Generator

## Heyden Chemical doubles its blanketing savings with Second Kemp Generator

Here's a case where simple mathematics paid big dividends at this Garfield, New Jersey plant. When Heyden Chemical—one of the nation's leading producers of formaldehyde, pentaerythritol, salicylic acid, etc.—installed its first Kemp Inert Gas Generator to furnish CO<sub>2</sub> for blanketing a special grinding operation, it was on more or less a test basis. Part of Heyden's constant search for newer, better, cheaper ways to improve its products. The rest of its blanketing needs were still being handled with CO<sub>2</sub> from large storage tanks in the plant.

#### **Immediate Savings with Kemp**

Results with the first Kemp Inert Producer were impressive. Now a second (see right) Kemp unit has been installed and actual savings over previous costs are estimated at over \$500 a month for the first year. In addition to dollars saved, Kemp Generators as sure a safe, dependable supply of chemically clean inerts. Deliver inerts at a special analysis . . . without fluctuations.

#### Kemp Designs Versatile

If you still rely on old-fashioned inert sources or are dissatisfied with present inert equipment, let Kemp help you, too. Kemp Engineers will be most happy to help solve your inert problems . . . show you how you can get similar results with fast-starting, easy-to-operate Kemp Generators. It costs you nothing to investigate. And it may save you real money.

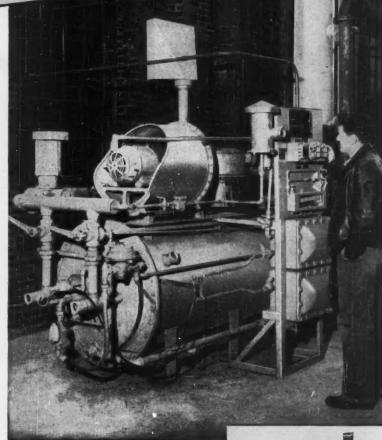
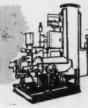


Photo at right shows close-up view of Komp Industrial Carbureter. Part of every Komp installation, it eliminates tinkering, waste. Assures complete combustion at all times. Reduces installation costs and maintenance.



For more complete facts and technical information, write for Bulletin I-10 to: C. M. KEMP MFG. CO., 405 East Oliver Street, Baltimore 2, Maryland.

KEMP OF BALTIMORE

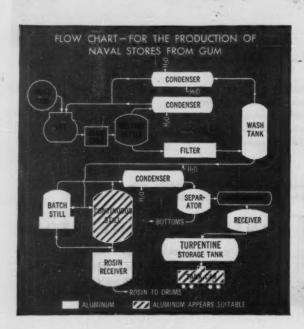


#### INERT GAS GENERATORS

CARBURETORS - BURNERS - FIRE CHECKS METAL MELTING UNITS - ADSORPTIVE DRYERS - SINGEING EQUIPMENT

## FLOW CHART - FOR THE PRODUCTION OF NAVAL STORES FROM WOOD CHIPS REFINED TURPENTINE REFINED PINE OIL REFINING REFINED DIPENTINE REFINED PINENE CONDENSER EVAPORATOR ROSIN ROSIN DISSOLVER CATION TOWER

NAVAL STORES are widely handled in ALCOA Aluminum equipment. Aluminum is used for gum cups, drums and tanks for shipment of final products. Aluminum resin kettles, evaporators, storage tanks, transfer lines, distillation equipment and piping are in service.



# Handling

Do it better,

ALCOA Aluminum offers many advantages to the pulp and paper industries

ALUMINUM SULFATE (alum) is handled in aluminum cooling trays to avoid product contamination. The rate of attack is low at room temperature and varies directly with acidity and temperature. Aluminum piping for alum solutions is also used in the paper industry.

HYDROGEN PEROXIDE is widely handled in ALCOA Aluminum. It is preferred material for handling and shipping hydrogen peroxide in all commercial concentrations, including 90% hydrogen peroxide. Aluminum distillation towers, heat exchangers, storage tanks, piping, tank cars and shipping drums are in service.

ROSIN has no action on ALCOA Aluminum. Aluminum does not catalyze the discoloration of rosin.

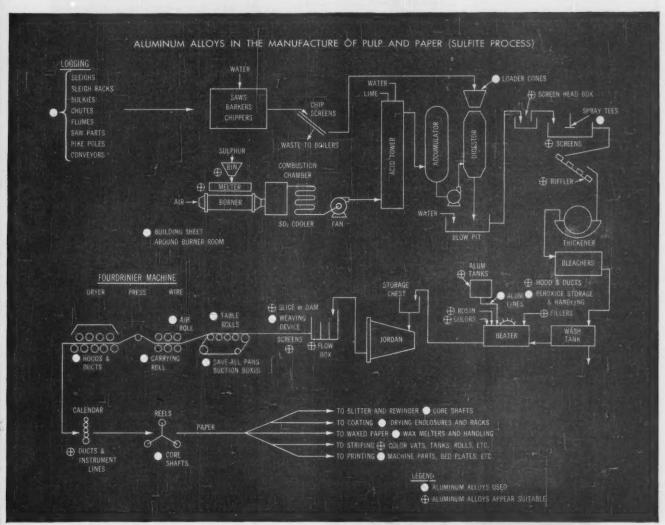
WAXES have no action on ALCOA Aluminum. Molten wax is molded in aluminum pans. Aluminum tubed "wax sweaters" are used in the manufacture of wax.

ALCOA's development engineers have firsthand experience with hundreds of such applications. To get in touch with them, simply write (on your company letterhead) to:

ALUMINUM COMPANY OF AMERICA 903-F Alcoa Building, Mellon Square Pittsburgh 19, Pennsylvania



# pulp or naval stores? cheaper...with ALCOA ALUMINUM



Write today for our new, FREE 80-page book, Process Industries Applications of Alcoa Aluminum.



# Here's Force-Balance\* Accuracy and Ruggedness in a Complete Line of Pneumatic Transmitters . . .

#### FLOW, LEVEL, or DENSITY TRANSMITTER-Differential Type



Available with differential ranges as low as 0-0.6" H<sub>2</sub>O (ranges this low are exclusive with the Republic Transmitter) and as high as 0-750 psi. Range may be suppressed up to 80% of full scale for density or level measurements.

#### PRESSURE and ABSOLUTE PRESSURE TRANSMITTER



Pressure ranges from 0-1°  $H_2O$  to 0-2000 psi. May be easily adapted for absolute pressure ranges from 0-25 mm Hg to 0-100 psia.

#### FLOW TRANSMITTER-Square Root Extracting Type



Automatically extracts square root function from flow measurements, permitting use of uniformly graduated charts and linear control devices. Available in all standard differential ranges.

#### LIQUID LEVEL TRANSMITTER—Bouyancy Type



Ranges to suit most applications. Can be used to measure level in closed tank; under pressure. Can also measure liquid-to-liquid interface.

#### LIQUID DENSITY TRANSMITTER-Bouyancy Type



Makes continuous density measurement of flowing liquids at line pressures to 300 psi. Fast response.

#### PNEUMATIC or PNEUMATIC-ELECTRIC TRANSMISSION

Special electrical meter body available for use with most Republic Pneumatic Transmitters. Permits locating pneumatic transmitter at metering point to cut piping costs and keep dangerous fluids out of control rooms.

# for Measuring FLOW — PRESSURE — LEVEL — DENSITY

Republic Pneumatic Transmitters are as simple in operating principle as a laboratory weigh scale—and just as accurate! The only real difference is that forces instead of weights are balanced for a measurement.

This force-balance principle both permits and requires the use of strong, durable construction. That's why Republic Transmitters can be ruggedly built for low maintenance without sacrificing accuracy and sensitivity. Standard models are guaranteed accurate to ½% of full scale.

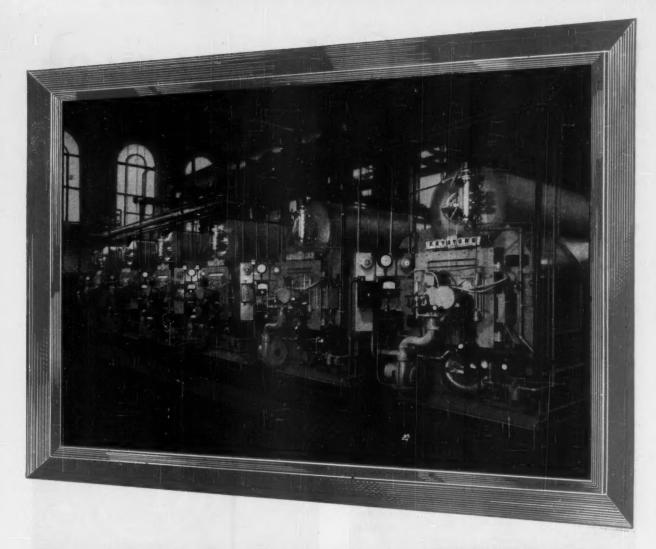
Range Flexibility — Changing ranges is merely a matter of shifting leverages in Republic Transmitters. Ranges may be changed as much as 2-1 on standard models, as much as 10-1 on double weighbeam models with no change of parts. Suppressed, reversed and compounded ranges are also readily available.

Corrosion Protection — Since process fluids are isolated to a small measuring chamber, special materials may be used for corrosion resistance. Minimum movement of fluid in chamber cuts maintenance when transmitter is used with dirty or viscous liquids.

These are but a few of the many features found in Republic force-balance Transmitters. Write for a free copy of Data Booklet with all of the details and complete description of various types.

\*In a force-balance pneumatic transmitter, a force produced by the process variable is balanced against a pneumatic pressure. The amount of air pressure required to produce a balance is proportional to the process variable and may be conducted to remote reading instruments or used as the measuring impulse for an automatic controller.

REPUBLIC FLOW METERS CO. • 2240 Diversey Pkwy., Chicago 47, Illinois



# There's Steam Economy in FLEXIBILITY

Above, six Erie City
Keystones meet a variable
beating and processing
steam load at the Obio
Masonic Home in
Springfield, Obio

Steam Generators in your plant. Multiple "Keystones" permit high efficiency operation. During periods of low loads, take one or more units off the line—for high loads, the rapid steaming "Keystones" respond quickly to increased requirements. Compact, completely factory assembled and Factory Fire Tested "Keystones" fit into any plant's variable steam needs. There is nothing to assemble in the field.

Need steam at some remote plant location indoors or outdoors? Investigate the use of one or more "Keystones." Bulletin SB-51 describes the fully automatically controlled Keystone.



You can depend on Erie City for sound engineering

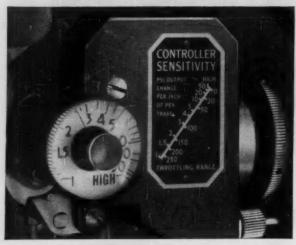
ERIE CITY IRON WORKS . Erie, Pa.

STEAM GENERATORS . SUPERHEATERS . ECONOMIZERS . AIR PREHEATERS

UNDERFEED AND SPREADER STOKERS . PULVERIZERS

# Which of these qualities

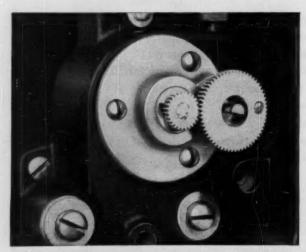
UNIT CONSTRUCTION...EASY
LOW COST MAINTENANCE...
SIMPLE ADJUSTMENTS...
VERSATILE...TROUBLE-FREE
...SIMPLE OPERATION...
RUGGED...LONG LIFE



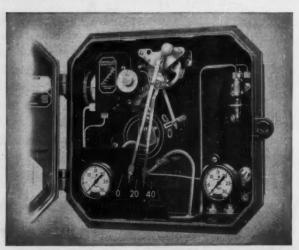
Sensitivity adjustment unit; single, continuous adjustment calibrated in specific units.



Improved sub-base permits easy, precise replacement of pre-calibrated actuating systems in field.



Interchangeable needle valves in Automatic Reset and PRE-ACT units. Wide range of adjustment, repeatable in all instruments.



FULSCOPE Indicating Controllers have same unit construction, mechanisms, characteristics, as recording types. Adjustable Sensitivity type shown.

# do you want in a Control Instrument?

# Taylor Fulscope Controllers have them all!

THIS outstanding controller has won the praise of engineers and instrument men across the country and throughout industry. For dependable year 'round performance it is unsurpassed. Here are some of the reasons why it has been the favorite for the last 16 years.

#### ADAPTABILITY

- 1. Extremely versatile. The same control mechanisms are available for Temperature, Pressure, Flow and Liquid Level—in either recording or indicating models, as locally mounted controllers, transmitters or controlling receivers. Interchangeable unit construction permits a small inventory of parts. Pre-calibrated units eliminate expensive checking. Easy visibility and accessibility of components means a unit back on the job with minimum down time.
- 2. Adaptable to any control problem because the FULS-COPE Controller has three control effects: (a) Proportional response, available in three forms: Fixed High, Adjustable, and Limited Range Sensitivity. (b) Automatic Reset Response, completely and continuously adjustable. (c) PRI-ACT\* Response (rate action) continuously adjustable. Any combination of these control responses may be used to provide any required quality of control. PRE-ACT and reset units are interchangeable.
- 3. Proper adjustment easily obtained. Control Response Adjustment Dials are calibrated in specific units, repeatable in all instruments. Optimum settings are quickly determined.
- 4. Controller action simply changed by lifting a spring clip and rotating set-point knob.

#### DEPENDABLE OPERATION

5. Control point always matches set point when automatic reset is used, thanks to fully pneumatic sensitivity reduction. Lowering sensitivity for stability does not

Single Duty FULSCOPE Recording Controller with Adjustable Sensitivity, Automatic Reset and PRE-ACT responses. Double Duty control mechanisms, with any combination of control responses, afford a great advantage on many applications.

reduce the effectiveness of the reset response. Result set point remains constant, regardless of load changes.

- 6. Trouble-free air system. Metal disc type filters are built-in features, easily removed for cleaning. Both relay air valve and nozzle are made of 18-8 stainless steel. Corrosion resistant parts, easily accessible for cleaning.
- 7. Lifelong accuracy. Fewer links and pivots. Dead spot and hysteresis practically non-existent due to lightweight stainless steel links and small diameter burnished pivots.

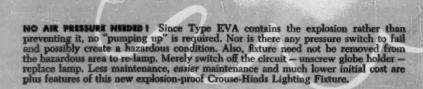
Why not call your Taylor Field Engineer for an evaluation of your control problems—or write for **Bulletin** 98151. Taylor Instrument Companies, Rochester, N. Y., or Toronto, Canada,

\*Trad

Taylor Instruments
MEAN ACCURACY FIRST

# NOW complete, exposion-proof lighting

Type EVA Explosion-Proof Lighting Fixture 200-Watt, with or without guard or reflector. Overall length: 13-3/16"



Type FSPC Explosion-Preof Tumbler Switch Condulets in 1, 2, 3-pole; 3 and 4-way; installations for acetylene and hydrogen areas!

# CROUSE-HINDS

# CONDULETS

UL-Approved for Class 1, Groups A & B Locations

From switch to lighting fixture, Crouse-Hinds' is the first complete lighting system designed and UL-approved for Class 1, Groups A & B, as well as C & D hazardous locations.

These explosion-proof fixtures and Condulets are entirely new — provide greater installation flexibility. Fixtures may be re-lamped — even in the presence of combustible gases — since gas-tightness is not a requirement for their safe performance. And they are safe . . . their heavier, more shock-resistant construction withstands the pressure of internal explosions without rupturing . . . their flame-tight joints prevent the escape of flames of flammable atmospheres.

\*Whether you're installing a complete explosion-proof lighting system — or merely converting a few of your Group C or D fixtures to these safer Group A's — your Crouse-Hinds Distributor can be a definite help. See him. Or write us.

# CROUSE-HINDS COMPANY

SYRACUSE 1, N.Y.

OFFICES: Birminghom — Boston — Bullalo — Chacogo — Cincinnois — Clevelund — Delina — Dervey — Dereit — Houston — Indian opolis — Kontos Circ. — Los Angeles — Hemphis — Milwauke — New Orleans — Hew York — Philodelphia — Philosurgh — Protinad, Ora — St. Louis — St. Paul — San Trancisco — Settlie — Tulsa — Washington — RESIDENT REPRESENTATIVES: Albant — Atlanta — Baltances — Baton Rouge — Charlotte — Chatancogu — Corpus Christi — Bacding, Pu. — Richmond, Vo. — Shrevepor Crouw-Hinds Company of Condos, Md. — Tarsento, Ons.





Type EAB Explosion-Proof Junction Condulets in ½", ¾", and i" hub sizes—through feed, £. T and X hub arrangements.



Type EY\$ Explosion-Proof Sealing Condulets In 1/2", 3/4" and 1" hub sizes.



Type EC Explosion-Proof Flexible Couplings and fixture supports in ½" and ¾" sizes.



Types UNY, UNL, UNF Explosion-Proof Condulet Unions female and male styles in ½". ¾" and 1" sizes.

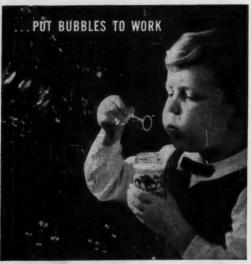
# HOW HERCULES HELPS...



→ "PLASTIC" INK with the necessary flexibility, hardness, and marproofness for printing on packaging films such as Saran and Mylar, is made possible by the use of Hercules<sup>®</sup> nitrocellulose as the film-former. Excellent adhesion is secured by plasticizing with Abitol<sup>®</sup> (Hercules Hydroabietyl Alcohol) and Hercules Synthetics B21 resin.



FINGERTIP CONTROL of fingerprint cards and other records is provided by modern automatic filing equipment. These record cards must be capable of being written on with pen and ink and must be protected from permanent damage in the event of accidental wetting. These necessary requirements are obtained through the use of Hercules Pexol® in sizing the paper.



▲ A PLAYFUL DEMONSTRATION of the exceptional filmforming properties of Hercules<sup>®</sup> CMC is provided by these soap bubbles. In industry, CMC has proved its value as a general-purpose, water-soluble film-former, adhesive, water binder, and suspending agent.



### HERCULES POWDER COMPANY

952 Market Street, Wilmington 99, Delaware. Sales Offices in Principal Cities

SYNTHETIC RESINS, CELLULOSE PRODUCTS, CHEMICAL COTTON, TERPENE CHEMICALS, I

ROSIN AND ROSIN DERIVATIVES, CHLORINATED PRODUCTS, EXPLOSIVES, AND OTHER

CHEMICAL PROCESSING MATERIALS

# WILFLEY ACID PUMPS

Wilfley Acid Pumps have the enviable reputation for efficiency and economy. They operate without attention, delivering trouble-free, cost-reducing performance on "'round-the-clock" schedules.

Available with pumping parts of the machinable alloys, as well as plastic, to meet all requirements. Individual engineering on every application. Write or wire for complete details.

Wilfley Model "AF" Pump with wetted parts of durable, corrosion-resistant plastics.

FeCl<sub>2</sub>

CuCl<sub>2</sub>

NaOH

KCl

H<sub>2</sub>SO<sub>4</sub>

and other solutions



A. R. WILFLEY & SONS INC., DENVER, COLORADO, U.S.A.

# NEW Advanced Design...

FOXBORD

NEW HIGH SUSTAINED ACCURACY... even under extreme operating and ambient conditions

NEW CONVENIENT ZERO ADJUSTMENT . . external—no need to remove weather-proof cover

FACTORIES IN THE UNITED STATES, CANADA AND ENGLAND

# d/p Cell Flow Transmitter...

NEW POSITIVE OVERRANGE PROTECTION . . . up to full 1500 lbs. cell rating

# 6 Major Achievements!

NEW FULLY ADJUSTABLE RANGE . . . from 0-50" to 0-250" H<sub>2</sub>0 differential

NEW AUTOMATIC INTERNAL DAMPING . . . fast, stable measurement

**NEW SIMPLICITY...** lowest cost installation

Pioneered by Foxboro 7 years ago, the d/p Cell\* Transmitter established a new standard of performance in flow measurement and control. Over 40,000 are maintaining that standard in every branch of industry today. Technical advances, based on this unequalled experience, now have added even further reliability, economy and convenience. Call your Foxboro representative for a demonstration. Write for new Bulletin 13-11.

\*Reg. U. S. Pat. Off.



Ist in flow measurement

THE FOXBORO COMPANY, 366 NEPONSET AVE., FOXBORO, MASS., U.S.A.

# Is One of These Your Dust Problem?

Check this list of AAF Dust Control Equipment applications covering a typical one month period.



FOUNDRY



Bagging Hammer Mill Rotary Kiln Rotary Dryer Drum Dryer Material Handling Ball Mill Fluid Energy Mill

Sand Conditioning System Swing Frame Grinding Electric Furnace Fumes Portable Grinding Vibrating Shakeout



#### METAL WORKING

Thread Grinders Belt Sander Stand Grinding Metalizing Magnesium Grinding Burring Automatic Screw Machines Automatic Buffing Cast Iron Machining



## MINING AND ROCK PRODUCTS

Coal Dryers Coal Tipple Copper Ore Milling Zinc Concentrate Dryer Quarry Drilling Bituminous Aggregate Dryer Calcining Furnace Coal Cleaning Plant Underground Crusher Taconite Ore Crusher



Woodworking Grain Bins Paper Dust Leather Brusher Laundry Dryers

Fur Cleaning Plastic Dust Candy Mixers Rayon Flocking Rubber Grinding Sugar Granulator Cream Cheese Concentrator Ceramic Insulator Grinding



Any of the above "ring a bell"? If not, remember this list represents only one month in AAF's 23 years of dust control experience—all of which is readily

available to help you find practical solutions to your dust problems. Why not call your local AAF representative now, or write-



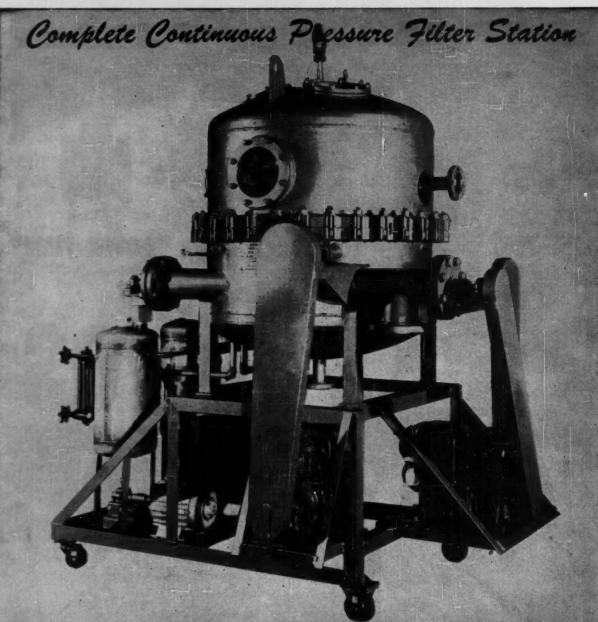
American Air Filter of Canada, Ltd., Montreal, P. Q. • 326 Central Avenue, Louisville 8, Kentucky



GATE VALVES . EMERGENCY VALVES . CROSS CHECK VALVES . CROSS VALVES . CHECK VALVES . GLOBE VALVES . PRESSURE RELIEF VALVES . COMPRESSION CHECK VALVES . LOADING VALVES

CORPORATION

2725 COLERAIN AVE. • CINCINNATI 25, OHIO



Liquid-solids separation through a pressure-vacuum differential has many applications in chemical processing.

Eimco designed, tested and approved pressure vessels of this type have found wide acceptance in many different kinds of jobs. Some of these use heat and others use inert gas. Some of the jobs involved combustible materials and others non-combustibles.

All of the installations are classified as far as Eimco is concerned to protect the customer's process or his idea and his flow sheet.

Eimco was selected in each case because Eimco's experience in the field of filtration is unsurpassed and Eimco's ability to engineer into each filter that extra quality that provides for greater product recovery and greater profits for the user.

Let Eimco's Research and Development Center

Let Eimco's Research and Development Center tackle your filtration problem. You will have the benefit of work by some of the best technologists in the industry, plus complete pilot plant data. Eimco backs the recommendations of its Research Center by a guaranteed performance.

## THE EIMCO CORPORATION

Salt Lake City, Utah—U.S.A. • Export Offices: Eimco Bldg., 52 South St., New York City

Now York, N. Y. Chicago, W. San Francisco, Calif. M Pasa, Texas Birminghom, Ale. Duluth, Minn. Kellogg, Ida. Baltimoro, Md. Pittsburgh, Pasadanh, Calif. Houston, Texas Landon, England Gateshoud, England Paris, Franco Milan, Italy Johannathung, South Africa







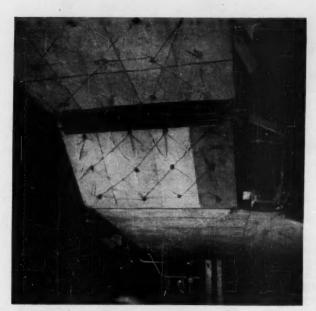






# PV SUPERTEMP BLOCK INSULATION

with the NEW "Precision-Finish"



A TRUE-CUT BLOCK! Eagle-Picher's new "precision-finish" is one of the most important insulation developments in years. Here's a highly efficient, all-purpose insulating block that is practically dustless.

GREAT STRUCTURAL STRENGTH! Eagle-Picher PV Supertemp Block meets your specific demands for long-lasting insulating block able to withstand a wide hot surface temperature range up to 1900 F. PV Block effectively resists steam and other moisture, does not disintegrate or lose thermal efficiency under heavyduty service.

**EASILY INSTALLED!** Lightweight PV Supertemp Block is easy to handle, requires only minimum reinforcing. It is easily cut to fit irregular areas—and no special tools are needed.

#### WRITE FOR FREE SAMPLE TODAY!

Compare Eagle-Picher PV Supertemp Block with other insulating blocks. You'll appreciate the improved temperature control that pays off in greater fuel savings. You'll sell yourself on the new "precision-finish"!

Since 1843



### THE EAGLE-PICHER COMPANY

Producing a complete line of industrial insulations

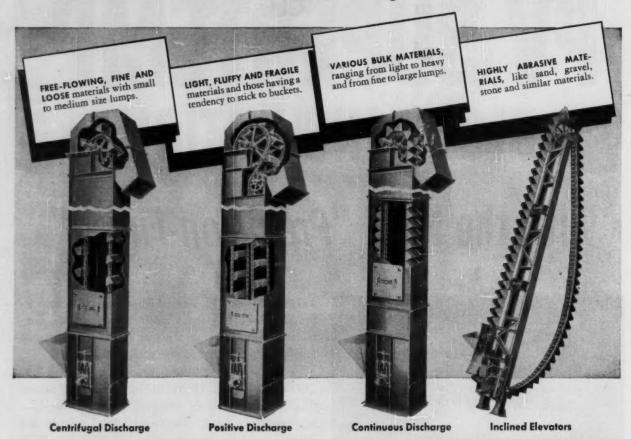
Cincinnati 1, Ohio

(Member of Industrial Mineral Fiber Institute)

(Conforms to Commercial Standard CS 117)



# LINK-BELT Bucket Elevators are tailored to suit your needs



# What kind of materials must you elevate?

SELECTING the right elevator to handle your material is no cut-and-dried procedure, but it's easy when you depend on Link-Belt. For top efficiency, a number of needs must be considered: the right buckets, correct bucket spacing for clean pickup and discharge, the right takeup, and a correctly designed hood that prevents back-legging. Link-Belt's broad line of 13 elevator types in four basic designs—plus a wide selection of quality malleable iron, Promal, or steel buckets—assures the right elevator leg to suit your operations exactly.

This specialization also explains why it pays to call in Link-Belt when designing a new plant, so that all elevating requirements can be satisfied from the outset. Equally important, Link-Belt offers lowest-cost installation, operating and maintenance . . . stemming from advanced design.

Whether you handle large or small quantities, get the advice of a Link-Belt materials handling expert. Call the Link-Belt office nearest you.



Twin Link-Belt continuous discharge bucket elevators provide continuous flow of materials at this cement mill. Frames are of structural steel, and casings can be provided when desired.

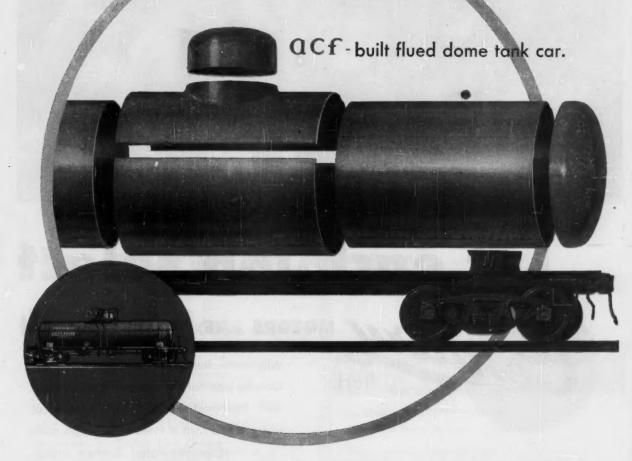


BUCKET ELEVATORS

LINK-BELT COMPANY: Executive Offices, 307 N. Michigan Ave., Chicago 1. To Serve Industry There Are Link-Belt Plants and Sales Offices in All Principal Cities. Export Office, New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N.S.W.; South Africa, Springs. Representatives Throughout the World.

# RING-SECTION CONSTRUCTION

# of DURADOME



ONLY DURADOME gives you the advantage of superior "ring-section" construction . . . formerly found only on pressure cars. This cylindrical construction means heavy steel all the way around – not just at the bottom – for greater durability and protection of costly ladings. Each tank is tested at pressures considerably higher than I.C.C. specifications.

Note that extra heavy gauge top center section - perfectly flued to form the dome base. This exclusive

feature gives you a smooth interior for unequalled ease of cleaning... much better application of lining... unmatched structural strength and corrosion resistance.

These exclusive DURADOME features ... plus the standardized underframe and all-welded insulation jacket ... are yours at no extra cost. Contact your Shippers' representatives for details on buying or leasing the revolutionary new DURADOME.

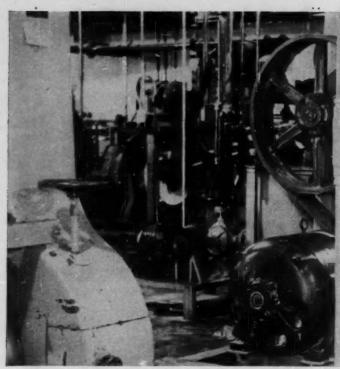
Specialists for over 35 years in the leasing, operation, maintenance and servicing of tank car fleets – now exclusive sales agent of QCf tank cars for industry.

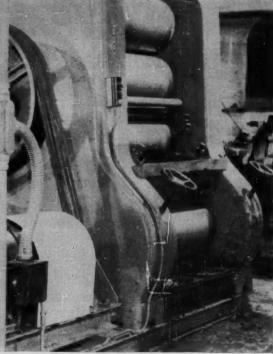


# Shippers' Car Line Corporation

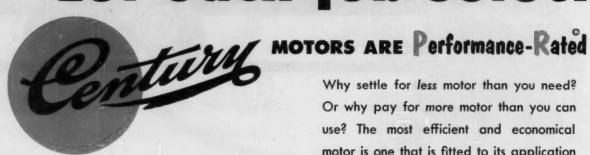
A subsidiary of QCf INDUSTRIES, Incorporated 30 Church Street, New York 7, N.Y.

CHICAGO, ILL. . HOUSTON, TEX. . SAN FRANCISCO, CAL. . MILTON, FA. . EAST ST. LOUIS, ILL. . SMACKOVER, ARK. . TULSA, OKLA. . NORTH KANSAS CITY, MO.





# Let each job select



Or why pay for more motor than you can use? The most efficient and economical motor is one that is fitted to its application ... A Performance-Rated Century Motor.

Performance-Rating means simply that from





Selective Speed Drive Power Unit...1 to 150 H.P....a wide range of flexible speed for automatic operation and where fine increments of speed are required.

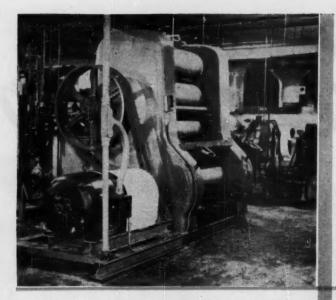




Squirrel Cage, Pelyphase Moters . . . ½ to 400 H.P. . . . available in drip proof and dust proof frames, with sleeve or ball bearings, foot or flange mounting (cushion base available through 5 H.P.).



Explosion Proof Motors . . . 2 to 50 H.P. . . . Underwriters Laboratory listed for safe operation in hazardous atmospheres.



for example: Five-roll refiners are powered by rugged 60 H.P. Century Performance-Rated Motors, chosen to stand up under punishing loads.



Century Motors for Modern Ideas . . . AC or DC . . . Single-phase or Polyphase . . . drip proof, dust proof or explosion proof frames.

# its own motor!

### TO FIT YOUR SPECIFIC NEEDS

Century's complete line of motors and generators you'll get precisely the right size, speed, frame enclosure and torque characteristics you need. Century application engineers or Authorized Century Distributors are always available to help you fit a Performance-Rated Motor to your job.



Slip Ring Moters . . . 1 to 400 H.P. . . . a favorite for applications requiring unusually low starting current. Available in drip proof, splash proof and dust proof frames.

## Performance-Rated Motors

1/8 to 400 H. P.



#### FOR THE FULL FACTS ON CENTURY PERFORMANCE-RATING, MAIL THIS COUPON TODAY

To CENTURY ELECTRIC COMPANY 1806 Pine Street, St. Louis 3, Mo.

Please send me information about

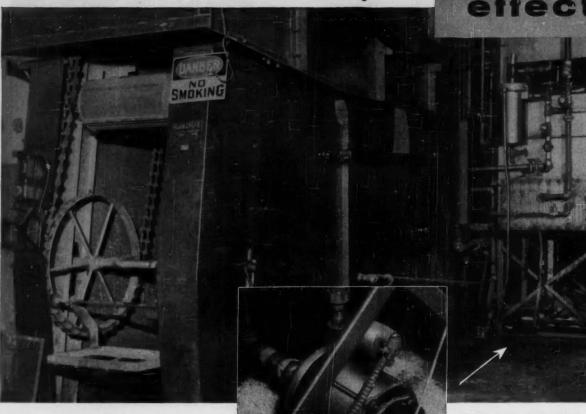
Offices and Stock Points in Principal Cities

### CENTURY ELECTRIC COMPANY

1806 Pine Street . St. Louis 3, Missouri

15

# Chempump



Leak-proof Chempump handles trichlorethylene in this distillation-type degreasing unit at I-T-E Circuit Breaker Company.

Seal-less, totally enclosed pump operates against a 20-foot head, giving a capacity of about 25 gpm. Since installation of *Chempump*, not a single drop of trichlorethylene has been lost!



Chempump combines pump and motor in a single hermetic unit. Pumped fluid is allowed to enter rotor chamber of motor; no shaft sealing device is required. Pump impeller and rotor are an integral unit, isolated from stator section by a corrosion-resistant, non-magnetic liner. Pumped fluid cools bearings, rotor, and stator—and lubricates bearings.

Approved by Underwriters' Laboratories. Available in a wide choice of materials . . . from 1/4 to 71/4 hp. Capacities to 250 gallons per minute. Heads to 195 feet.

Chempump can't leak!

# tremendous savings

# at I-T-E Circuit Breaker Co.

Only Chempump seal-less pumps provide these cost-saving benefits:

- No seals, no stuffing boxes . . . can't possibly leak . . . end fluid losses.
- No lubrication, no external shaft, no coupling . . . virtually eliminate maintenance.
- No contamination of process fluids.
- Handle hazardous liquids with complete safety.
- Leak-proof under extreme vacuums or pressures.

#### Here's proof:

Savings of \$45 a day in trichlorethylene alone (not to mention maintenance) are attributed to the leak-proof Chempump installed on a distillation-type degreaser at I-T-E Circuit Breaker Company, Philadelphia. With the ordinary centrifugal previously installed, the pump packings and packing lubricants were destroyed by the solvent. The shaft also scored repeatedly, intensifying packing problems.

Despite packing replacement with both standard and special packings, two or three times a week, the unit lost 25 gallons a day! Since installation of the Chempump, however, not a drop of trichlorethylene has been lost! The pump has operated for more than 4000 hours; the only maintenance—two quick bearing changes.

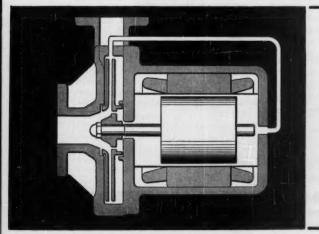
Combining motor and pump in a single unit, Chempump represents the most significant advance in pump design in half a century. Normally hard-to-handle fluids—volatile, toxic, corrosive, explosive, "hot," or sensitive—just can't leak or become contaminated! The only maintenance required is a simple bearing change—when required after periodic inspections—made without special tools... with only minimum down-time.

Here's just one more example of how *Chempump* has licked a tough leakage problem. Your process can benefit through *Chempump*, too. For details, send for new 16-page Bulletin 1010.

Engineering representatives in over 30 principal cities in the United States and Canada.

Chempump

CHEMPUMP CORP. • 1300 E. MERMAID LANE • PHILADELPHIA 18, PA.



CHEMPUMP CORP. • 1300 E. MERMAID LANE • PHILA. 18, PA.

Please send me details on Chempump for:

(application)

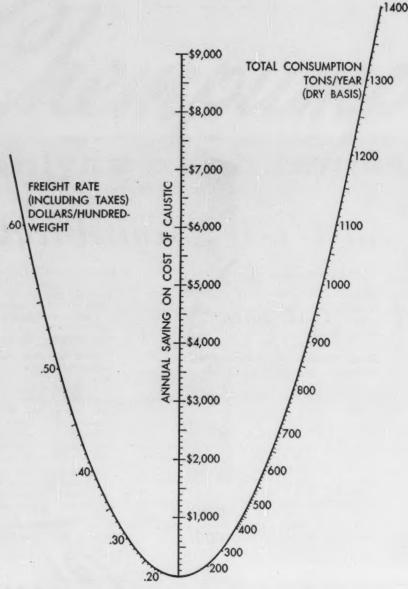
Capacity\_\_\_\_\_\_ Total dynamic head\_\_\_\_

Name\_\_\_\_\_Title\_\_\_\_

Company \_\_\_\_\_

Address

City Zone \_\_\_\_State \_\_\_



Which saves you more ... 50% or 73% Caustic Soda?

This nomograph can help you decide Are you using the caustic solution that's least expensive for you? A few seconds' calculation with this nomograph will help you decide.

How to find if you can save on 73% caustic soda Simply draw a line from your freight rate (including taxes) to your annual consumption in tons on a dry basis. Your approximate savings will appear where this line intersects the center line of the nomo-

This figure represents your savings

on freight charges after the \$2.00 premium price on 73% caustic soda has been deducted.

From this figure you must deduct a depreciation charge based on the cost of dilution equipment. Your Hooker technical service man is ready to advise you on the equipment needed and its cost.

Double-check your findings this way Befo e you make a final decision on 50% or 73%, give yourself the advantage of expert technical advice. Let your Hooker technical service man

show you what equipment you will need for 73%. He will figure your exact savings-based on a realistic study of your operations.

For quick service, write or phone the nearest Hooker office.



"CAUSTIC SODA BUYER'S GUIDE" is the title of a new pocket-size booklet we'll be glad to send you free. Contains helpful facts on the economics of 50% and 73% solutions;

other forms of caustic soda; capacities of tank cars and other containers; useful shipping information. Write us for



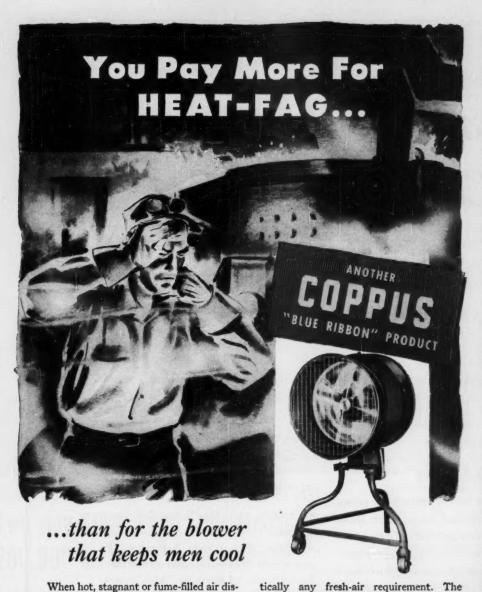
1905-Half a Century of Chemicals

From the Salt of the Earth-1955

#### ELECTROCHEMICAL COMPANY

5 FORTY-SEVENTH ST., NIAGARA FALLS, N. Y.

NIAGARA FALLS . TACOMA . MONTAGUE, MICH. . NEW YORK . CHICAGO . LOS ANGELES



tically any fresh-air requirement. The Coppus "Blue Ribbon" is the sign of precision workmanship and trouble-free, longlasting operation. Check and mail the coupon for exact information. Sales offices in THOMAS' REGISTER. Other "Blue Ribbon" Products in CHEMICAL ENGINEERING CATA-LOG, REFINERY CATALOG, BEST'S SAFETY DIRECTORY, MINING CATALOGS.

# OTHER COPPUS "BLUE RIBBON" **PRODUCTS**









PLEASE SEND	ME INFORMATION	ON SUPPLYING	FRESH AIR TO MEN WORKING
in tanks, tank cars, drums, etc. in underground cable manholes. in aeroplane fusilages, wings, etc. on coke ovens.	on boiles repair jobs.  COOLING: motors, generators, switchboards. wires and sheets. general man cooling.	exhausting welding fumes.  stirring up stagnant air wherever men are working or material is drying.  drying. wells, sheets; etc., after treated with coating material.	NAME
(Write here any special venti	around cracking stills.		

tresses your men, your production suffers too. Give men around furnaces or hot proc-

esses, or in confined areas, a steady supply

of fresh, cool air with Coppus Blowers and

Exhausters and watch their efficiency

Coppus "Blue Ribbon" product for prac-

There's a portable, easily adaptable

jump to a more profitable level.

# A 118 Year Old Company Changes its Name

# AMERICAN LOCOMOTIVE COMPANY is now ALCO PRODUCTS, INCORPORATED

Why this change in a name so widely recognized and long established?

To our many employees and customers—those who know us best—the change is a logical one . . . one that many felt was a long time coming.

Our company has expanded its activities and diversified its products until our former name applied only to a part of our business. It no longer represented our new operations, which have grown beyond our important responsibility as a locomotive supplier.

Look at last year, for example . . .

In 1954, we introduced 18 new products for the chemical, petroleum,

power, railroad, and atomic energy markets.

That alone underscores the obvious fact that we are no longer a specialty company but have become one of America's broadly based industrial manufacturers.

So today, this new name has been adopted to reflect the vigorous new company that stands behind it. To our many friends, of course, we have been known for years as "Alco"—now it is official.

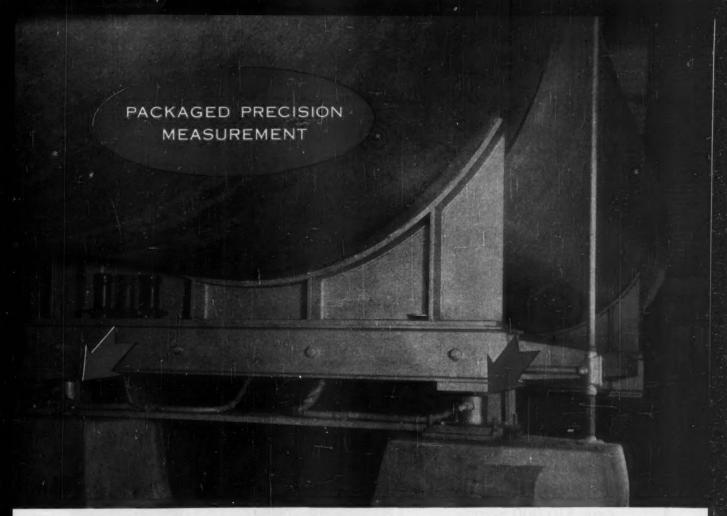
And we shall continue to produce traditional "Alco" quality in our new as well as our long-established product lines.



FORMERLY AMERICAN LOCOMOTIVE COMPANY
New York, N.Y.

Sales offices in all principal cities. Manufacturing plants in Schenectady, Auburn, and Dunkirk, New York; Latrobe, Pennsylvania; Chicago Heights, Illinois; Cincinnati, Ohio; and Beaumont, Texas.

Sales Representatives throughout the World



Stanley Home Products, Inc. checks Freon losses as

# Two tiny SR-4° Load Cells weigh 200,000 lb. tanks automatically

Baldwin's "Packaged Precision Measurement," neatly solved the handling of large volumes of Freon at the Stanley Home Products plant in Easthampton, Mass. A constant record of stored and used quantities was needed to avoid excessive leakage and evaporation losses.

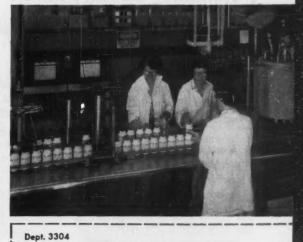
Continuous automatic weighing of their two 15,000 gallon storage tanks with Baldwin SR-4 Load Cells answered Stanley's problem perfectly. Two small SR-4 compression-type 50,000 lb. load cells were installed as supporting members on the concrete base at one end of each tank. These support exactly half the load of the 200,000 lb. tanks and the instruments are calibrated to read only the weight of

the Freon in the storage tanks.

Reinforced flexible hose at inlet and outlet eliminates effect of connecting piping on weighing accuracy.

This Baldwin system gives Stanley weighing accuracy within ½ of 1% of scale (200,000 lbs.). Baldwin-engineered instrumentation provides remote indicators at the tank car siding and recorders at a centralized control panel. The weighing system controls a motor-driven pump at the siding, shutting it down automatically when the tanks have 13,500 gallons of Freon.

Packaged Precision Measurement can solve similar problems for you. For detailed information on SR-4 Device applications and instrumentation use coupon today. Baldwin strip chart recorders on wall (lower photo) show rate of consumption of Freon. Recorders are connected by electrical cables to SR-4 Load Cells under one end of 15,000 gallon tanks on other side of wall (upper photo).

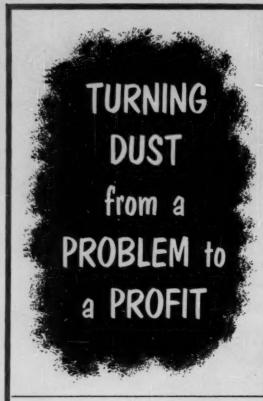


Baldwin-Lima-Hamilton Co	orp.	
Philadelphia 42, Pa.		
(In Canada: Peacock Bros	., Ltd., Montreal, Quebec	:)
Please send me the follow	ving new literature	
☐ Bulletin 4300 (Introduc ☐ Bulletin 4301 (SR-4 Lo ☐ Bulletin 4302 (SR-4 w		
Bulletin 4306 (SR-4 Fig	uid Pressure Cells)	
Name	Title	
Company		
Address		
City	Zone	State



**Eddystone Division** 

BALDWIN - LIMA - HAMILTON



Wheelabrator® DUSTUBES® save \$10,000 yearly for Lord Mfg. Co. ventilating Banbury Mixers



Lord Mfg. Co. of Erie, Pa., operates two Banbury mixers to mix carbon black, sulphur and other materials with rubber stocks.

Hoods over the hopper, oven hopper, exhaust bearings and exhaust discharge gate of each Banbury keep carbon black and other material from escaping into the air. Because this material is collected in the dry state by the cloth filter tubes in two Wheelabrator Dustube Collectors it can be returned to the batch. Savings of \$10 to \$15 per mixer per 8 hour day are achieved.

Besides the savings, however, the return of the material insures proper mixture throughout the batch cycle and maintains the quality of the batch.

In addition, the Dustube Collectors simplify housekeeping and establish better working conditions in the department.

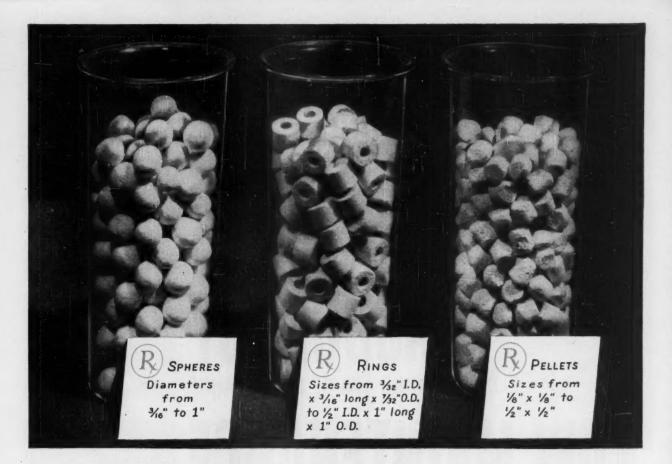
Investigate the many benefits of Wheelabrator Dustube Collectors. Send today for Bulletin 372.



high-efficiency cloth-tube dust collectors

AMERICAN WHEELABRATOR & EQUIPMENT CORP.

347 Byrkit St., Mishawaka, Indiana



# What are your catalyst carrier applications?

Norton engineered and prescribed carriers offer you important processing advantages

What do you need? An inert, high alumina carrier for fixed bed oxidation reactions — such as those involved in the manufacture of phthalic anhydride, maleic anhydride and ethylene oxide?

An inert, low density carrier for use as a space filler or tower packing?

Norton ALUNDUM\* fused alpha alumina carriers are proving highly successful in such processes. Containing 77% to 89% alumina, they are outstanding for chemical stability and resistance to abrasion and erosion — and their low density is a valuable quality in packing and filling applications.

ALUNDUM carriers are commercially available in the form of spheres, rings and pellets. Also available in experimental quantities are carriers made of MAGNORITE\*, CRYSTOLON\*, Fused Stabilized Zirconia and Kyanite materials.

#### **ALUNDUM Spherical Carriers**

provide uniform beds in catalytic converters, reducing channeling and pressure drop to a minimum. Medium porosity spheres (40%-44%) have a network of open pores on the outside surface only. These are specifically recommended for applications where the carrier is coated with a catalyst. High porosity spheres (45%-49%) have an internal as well as external network of pores, and are suitable for applications where the carrier is impregnated with a catalyst.

#### Other Norton Refractories

for chemical processing include porous mediums, laboratory ware, ALUN-DUM, MAGNORITE, CRYSTOLON, and Fused Stabilized Zirconia shapes. All are engineered and prescribed to give you the best possible R — the most effective combination of physical characteristics plus thermal, chemical and electrical properties. For details call in your Norton Refractories Engineer, or write, mentioning your specific requirements to Norton Company, 505 New Bond St., Worcester 6, Mass. Canadian Representative: A. P. Green Fire Brick Co., Ltd., Toronto. Canada.



D -

Engineered...R...Prescribed

Making better products... to make your products better

\*Trade-Marks Reg. U. S. Pat. Off. and Foreign Countries

# NEWS IN TEMPERATURE MEASUREMENT AND CONTROL! HAGAN MODEL "P" AMPLIFIER SETS NEW RECORDS FOR

SPEED

**FULL SCALE RESPONSE IN 0.1 SECOND** 



**ACCURACY** 

PLUS OR MINUS 1/4% OF INPUT RANGE



LOW MAINTENANCE

NO SLIDE WIRES - NO REVERSING MOTORS



# CONTROL

## WITH HAGAN ELECTRO-PNEUMATIC CONVERTER

The new Hagan Model "P" DC Amplifier is a key instrument in the new and advanced PowrAmp line of electro-pneumatic and electro-hydraulic measurement and control components with unusual sensitivity and accuracy. It may be used with any of the following primary inputs: Thermocouples, Thermistors, Radiation Pyrometers, DC Strain Gages, Resistance Thermometers, Pressure Pick-Ups, and many other low voltage DC inputs. Check these many features of this remarkable new instrument:

Measurement continuous—no slide wires and motors • Broad frequency response—flat to 10 cps • Unsuppressed instruments—no standardization necessary • Flexible voltage and double current outputs • Steady calibration—long time measurement accuracy—feedback stabilized • Fixed or adjustable zero suppression with remote zero suppression available • Multiple ranges





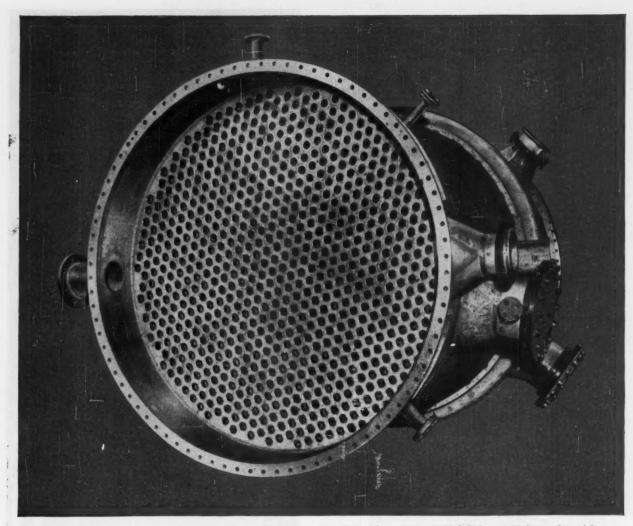
HAGAN POWRAMP MODEL "P" DC AMPLIFIER

Send for Hagan Bulletin MSP-111.1 for the full story on the flexibility and range of application of this versatile instrument.



HAGAN CORPORATION
HAGAN BUILDING . PITTSBURGH 30, PENNSYLVANIA

Control Systems for Aeronautical and Automotive Testing Facilities - Boiler Combustion Control Systems - Ring Balance Flow and Pressure Instruments - Metallurgical Furnace Control Systems



Stainless steel converter—7' 6" O.D. by 12' 6", face to face of flanges. Equipped with 745 tubes 2" in diameter by 10' 0" long.

# How Downingtown Skill and Experience Assure Quality Processing Equipment for Your Plants



Generator air pressure tank built at Downingtown of carbon steel—8' 0" I.D. x 23' 8" overall. Designed and tested for 200 pounds W.P. End plate approximately 8" thick.



Aluminum cyclone separator, 6' 6" O.D. x 30' 11" long. Fabricated at Downingtown of type 52S aluminum.

Fabricating the complex pressure vessels which turn flow charts into profitable process plants has been the specialized business of Downingtown Iron Works for many years. We've accumulated the skill and experience required to fabricate accurate, smooth-working process equipment to meet your specifications. We pioneered in the application of stainless steel and other alloys for corrosion-resistant pres-

sure vessels.

We've developed efficient welding techniques—approved for ASME Code work—which assure sound, neat, extra-strong welds. We're skilled at working and welding many alloys and clad steels, as well as the carbon steels and stainless steels. Our new bulletin PF pictures dozens of chemical process pressure vessels fabricated at Downingtown. Write for your copy today.

# Downingtown Iron Works, Inc.

140 Wallace Ave., Downingtown, Pennsylvania New York Office: 52 Vanderbilt Avenue, New York 17, N. Y.

HEAT EXCHANGERS—TOWERS—PRESSURE VESSELS—STORAGE TANKS STEEL AND ALLOY PLATE FABRICATION

DIVISION OF: PRESSED STEEL TANK COMPANY
Manufacturer of Hackney Products • Milwaukee 14, Wisconsin

CONTAINERS AND PRESSURE VESSELS FOR GASES, LIQUIDS AND SOLIDS

CHEMICAL ENGINEERING—June 1955

# AIR AT WORK

New two-stage <u>Ro-Flo</u> compressor provides constant efficiency...cuts maintenance

Efficiency and air supply are constant year after year with *Ro-Flo* compressors. Even if wear occurs, it automatically compensates for itself so that air supply is unaffected,

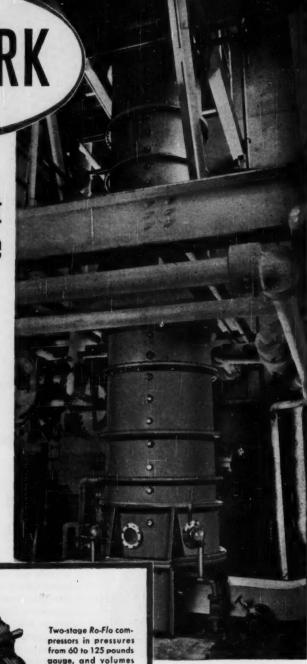
In addition, rotary design eliminates practically all vibration. No heavy foundations are needed.

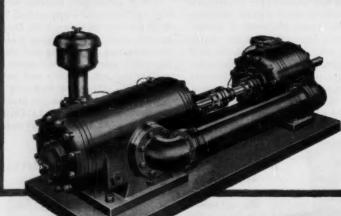
Maintenance is cut too! There is no wear and tear from shock and vibration . . . no hardto-maintain pistons and valves.

For constant efficiency . . . overall savings on air, modernize air supply with two-stage *Ro-Flo* compressors.

GET THE FACTS: Contact your A-C office or write Allis-Chalmers, Milwaukee 1, Wis.

Ro-Flo is an Allis-Chalmers trademark.



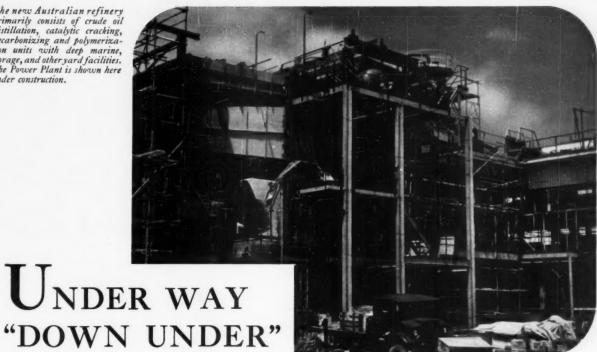


Iwo-stage Ro-Fo compressors in pressures from 60 to 125 pounds gauge, and volumes from 250 to 1800 cubic feet per minute. Singlestage units for lower pressures.



**ALLIS-CHALMERS** 

The new Australian refinery primarily consists of crude oil distillation, catalytic cracking, decarbonizing and polymeriza-tion units with deep marine, storage, and other yard facilities. The Power Plant is shown here under construction.



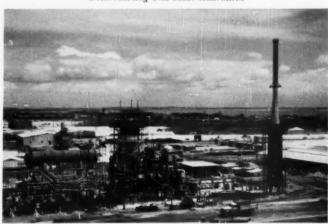
At Botany Bay, near Sydney, Australia, Kurnell Refinery soon will go "on stream." Designed for completely integrated processing of 22,000 barrels per calendar day of Eastern Hemisphere crude oils, it is a project of our client, Australian Oil Refining Limited, an affiliate of California Texas Oil Company, Limited.

Stone & Webster Engineering Corporation and its British affiliate, E. B. Badger & Sons Limited, are responsible for the design of the crude oil distillation unit and yard facilities and for the construction management of the entire project.



Crude Oil Distillation Unit under construction

Decarbonizing Unit under construction





Catalytic Cracking Unit under construction



Write or call us for information as to how our experience may be of assistance to you.

#### STONE & WEBSTER ENGINEERING CORPORATION BADGER PROCESS DIVISION

AFFILIATED WITH E. B. BADGER & SONS LIMITED (LONDON)

New York Chicago Pittsburgh Houston San Francisco Los Angeles Seattle Toronto Boston

# There's a GAULIN Triplex Pump for every job



#### **Name Your Capacity**

There's a Gaulin to handle your capacity from 50 GPH up to 5000 GPH.

#### **Name Your Pressure**

Gaulins are designed for 3 basic pressure ranges — up to 3000, 5000 and 8000 psi.

#### Name Your Product

Only Gaulin designs a specific cylinder to handle every product efficiently, economically. Note some of our designs below.

# With Maintenance-Saving Horizontal Design Stainless Steel Construction

#### For Transfer, Metering, Spray Drying

A Gaulin Triplex Pump is a rugged, heavyduty machine built to minimize operating, inspection, and maintenance costs. Compact. Simple. Dependable. Its horizontal design positively separates your product from the crankcase . . . and makes every part easy to get at.

Just lift two plates and a Gaulin drive and plunger assembly is convenient for inspection or repair.

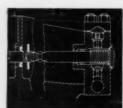
A Gaulin Cylinder may be disassembled in a matter of minutes:

Vibrationless. A Gaulin is practically free of vibration.

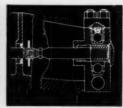
**Corrosion-proof.** All product contacting parts are stainless steel. Ceramic plungers or other materials are available for special applications.

Rugged Dependability. Thousands of installations with well-known companies prove a Gaulin provides unusually long service at minimum cost.

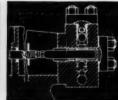
Write for Bulletin



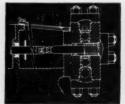
For Field, non-abrasive products the Gaulin Spring-Loaded Poppet Valve provides low initial cost and low maintenance.



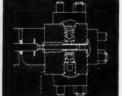
For Viscous, heavy-bodied products, the Gaulin Ball Valve (spring-loaded packing, inserted seats) provides excellent pumping efficiency and minimum maintenance.



For Slightly Abrasive, viscous products, the Gaulin Ball Valve (adjusting screw packing, inserted sects) keeps maintenance costs



For Stightty Abrasive, viscou products, where maintenanc must be accomplished in minutes the Gaulin Ball Valve with re movable seats (spring-loader pocking) cuts maintenance time to



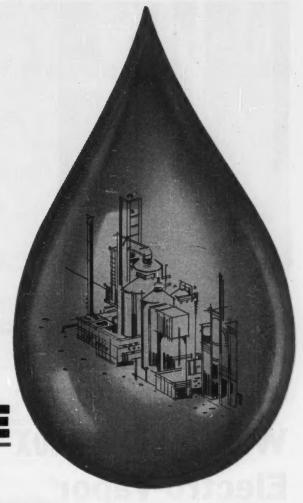
For Very Abrasive products, the Gaulin Ball Valve (with adjusting screw packing, removable seats) provides the ultimate in low cost maintenance.



# Manton-Gaulin

Manufacturing Company, Inc., 71 Garden St., Everett 49, Mass.

# H's Here ! Sinclair TOLUOL XYLOL PARAXYLENE and HEAVY AROMATICS

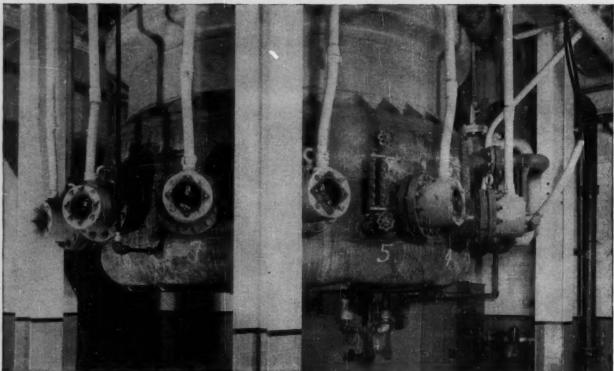


Completion of the Sinclair Aromatics Unit at Marcus
Hook, Pa., Refinery means that a new and dependable source of supply of
important petro-chemicals is now available to you. Designed for quantity
production of high-purity Toluol, Xylol, ParaXylene and Higher boiling
aromatics, this new Sinclair unit is a big step forward in meeting
a basic industrial need.

If your manufacturing processes call for reliable supplies of these aromatic hydrocarbons, Sinclair is ready to serve you. For complete information call or write to...

SINCLAIR CHEMICALS, INC.

(Subsidiary of Sinclair Oil Corporation) 600 Fifth Avenue, New York 20, N. Y., CIrcle-6-3600



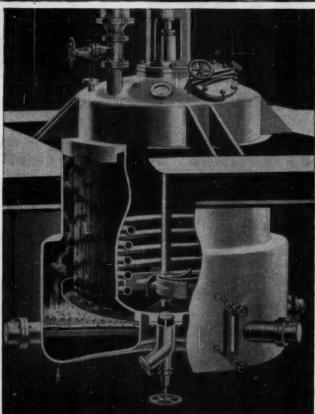
This 2000-gallon resin kettle, heated and cooled by a Blaw-Knox Electro-Vapor Dow-Therm System, was built especially for the Armstrong Paint and Varnish Works.

### Why a BLAW-KNOX Electro-Vapor<sup>®</sup> Resin Kettle?

A Blaw-Knox Electro-Vapor Heating System, designed for each specific requirement, is the newest, most modern method of chemical process heating. It combines all the advantages of electricity and Dow-Therm heating to provide a heating system that is simple in principle, efficient in operation . . . one that requires limited space. Applied to a resin kettle, such as the one illustrated, it puts at your disposal controlled heat at the right temperature for your resin operations.

### Controlled heat...where you want it... when you want it... at the right temperature

Whether your resin problem needs a small, simple cooker or a 2000- to 3000-gallon Electro-Vapor Resin Kettle, Blaw-Knox can build it for you. Call on us any time. Make it today.



Cut-away view of Blaw-Knox Electro-Vapor Heated Resin Kettle, showing simplicity of principle.

### **BLAW-KNOX COMPANY**

**BUFLOVAK EQUIPMENT DIVISION** 

1551 Fillmore Avenue, Buffalo 11, New York

You get more than a mixer at

### SPROUT-WALDRON

You get many plus values when you deal with Sprout-Waldron. In mixers, you get a wide choice of styles and sizes—models for the gentle handling of delicate materials or models for severe action on heavy, dense substances. Every model can be tailored to fit your needs by Sprout-Waldron's unique "adaptioneering" methods.

You also get reliable guidance on installations and applications from our engineering representatives and engineering staff, who are thoroughly experienced in solving mixing problems for the processing industries.

Typical of the Sprout-Waldron representatives is Ollie Morgan, pictured



Ollie Morga

Before joining Sprout-Waldron, he worked as a sales engineer for Wallace & Tiernan, handling scales, feeders, and associated equipment. His helpful suggestions to solve processing problems are well known to his many customers. With such men to help you, you're bound to buy right at Sprout-Waldron.

### SPROUT-WALDRON

### CONTINUOUS MIXERS

### Double Agitator



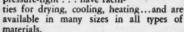
Ideal for adding hot or cold liquids, viscous or s...for blending

otherwise, to dry materials...for blending two or more materials...for mixing thin and dense slurries...for blending products from holding bins to assure uniformity of large shipments...all on a continuous basis.

### SPROUT-WALDRON

### VERTICAL MIXERS

For reasonably free-flowing materials, Sprout-Waldron verticals offer many advantages. They're compact—one with 1250 cu. ft. capacity occupies only 90 sq. ft. of floor space. They save power—a 1500 cu. ft. one operates on as little as 30 h.p. They're self-cleaning... dust-tight... pressure-tight... have facili-





where individual particles lose their identity. Materials are rubbed between opposing rotating discs, lumps are eliminated, thorough blends assured. You produce higher quality end products.

### SPROUT-WALDRON

### MATERIALS HANDLING EQUIPMENT

To get materials to and from mixers, Sprout-Waldron offers complete lines of screw and belt conveyors, bucket elevators, feeders, and the revolutionary Pneu-Vac air handling system.

### For Perfect Blends

OF DRY AND SEMI-DRY MATERIALS



**Horizontal Batch Mixers** 

STYLE "B"

When your problem calls for the rapid, intimate mixing of small percentages of a number of critical ingredients with a large bulk of basic material or filler ... the answer is a Sprout-Waldron Style "B" Horizontal Batch Mixer.

It loads, blends, and discharges rapidly...is clean, dustless, sanitary. Effectively handles all types of dry, damp, and free-flowing wet materials. Available in a wide range of standard sizes—from 1 cu. ft. up to 1700 cu. ft.—to meet every capacity and power requirement. Built of any type of material required, and with discharge gates to suit all applications. Can be equipped with facilities for heating, drying, or cooling. Should you desire special variations, Sprout-Waldron "adaptioneering" methods can adapt the equipment to meet your needs.

WRITE FOR FULL DETAILS

### SPROUT-WALDRON

Manufacturing Engineers Since 1866

15 LOGAN STREET . MUNCY, PA.

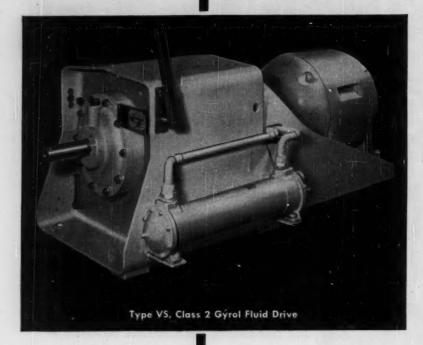
Equipment for SIZE REDUCTION, MIXING & BLENDING, PELLETING
& CUBING, BULK MATERIALS HANDLING, PRODUCT
CLASSIFICATION

Facilities for fabricating, machining, custom founding, woodworking, laboratory testing

992

### American Blower Gýrol Fluid Drives are

# Mighty Popular with Equipment Operators



Here's why:

It's the flexibility and simplicity of Gýrol Fluid Drives that make them popular with equipment operators. No special motors or complicated starting controls are needed (saving power and maintenance costs); yet, Gýrol Fluid Drives offer operators such welcome features as adjustable, stepless speed control over a wide speed range, overload protection, smooth acceleration and complete shock absorption. These features reduce operator fatigue and strain because equipment operation is simpler and quieter.

You can get complete data on Gýrol Fluid Drives from your nearest American Blower Branch Office.

### **Typical Applications**

PUMPS, AGITATORS, MIXERS
CONVEYORS, CABLE & ROPE MACHY
FANS AND BLOWERS
CENTRIFUGAL COMPRESSORS,
PAPER AND PRINTING MACHY
TEXTILE MACHY

### Advantages of using Fluid Drive on Conveyors

Besides providing smooth acceleration, Gýrol Fluid Drive is an excellent means of adjusting conveyor speeds to suit process or production demands. With manual control, the conveyor can be operated at speeds well below normal speed, can even be stopped completely without shutting down motor. If conveyor jams, the Fluid Drive acts as automatic shearpin since output shaft stalls until jam is cleared.

### American Blower products serve industry

- AIR CONDITIONING, HEATING, VENTILATING EQUIPMENT
- INDUSTRIAL FANS AND BLOWERS
- . CENTRIFUGAL COMPRESSORS
- . GYROL FLUID DRIVES
- . DUST COLLECTORS

AMERICAN BLOWER CORPORATION, DETROIT 32, MICHIGAN CANADIAN SIROCCO COMPANY, LTD., WINDSOR, ONTARIO

Division of American Radiator & Standard Sanitary Corporation

AMERICAN

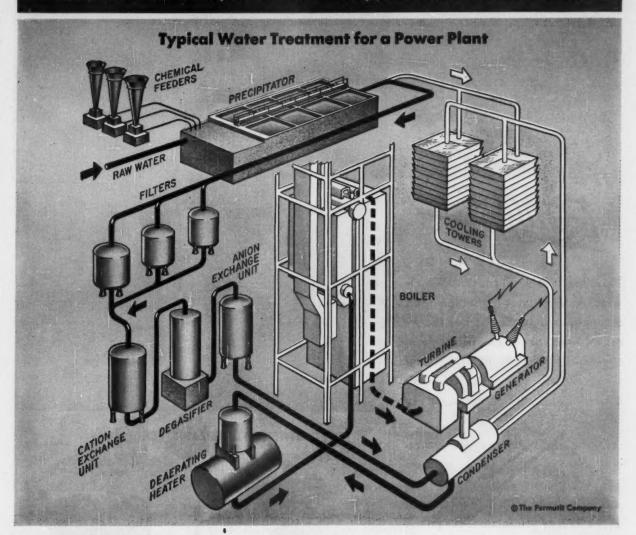


BLOWER

Serving bome and industry: AMERICAN-STANDARD - AMERICAN BLOWER - CHURCH SEATS & WALL
TILE - DETROIT CONTROLS - KEWANEE BOILERS - ROSS EXCHANGERS - SUNBEAM AIR CONDITIONERS

WATER:

Modern power plants require "ultra-pure" water for their highpressure boilers. To provide it . . . new equipment produces the equivalent of commercially distilled water . . . at far lower cost!



### 99.9998% Pure Water for Power Plants

Ordinary water with just the dirt and hardness removed was good enough for old-time boilers. But today's efficient plants operate at high steam pressures . . . up to 2600 lb. psi. Future plants will operate at 5000 psi. and up!

- At high pressures any mineral element in the water causes trouble. For example: The few parts per million of dissolved siliea in practically all water, while harmless for drinking, builds up as a glass-like deposit on turbine blades . . . impairs the balance and efficiency of the turbine.
- Simplified flow sheet shows how a muddy river water might be demineralized: The Precipitator, with coagulants and other chemicals from the feeders, takes out mud, most suspended

matter and hardness. (This clarified water is adequate for the cooling-water system . . . cooling tower, condenser.)

Next—the filters remove final traces of suspended matter. The cation exchanger takes out metallic ions (calcium, magnesium, sodium, iron, etc.). The degasifier removes carbon dioxide (formed in the cation exchanger). The anion exchanger takes out chlorides, sulfates, etc. and silica. The deaerating heater preheats the water for the boiler and removes corrosive gases,

Depending on the condition of the raw water and the type of demineralizer, total solids are often reduced to less than 0.2 parts per million!

• Oldest and largest U. S. firm in the business, The Permutit Company, de-

signs and builds complete water-conditioning systems like that shown above for leading utilities and industrial power plants. Other Permutit installations are reducing costs or improving products for almost any industry you can name. For advice on any water conditioning problem, simple or complex, write: The Permutit Company, Dept. CE-6, 330 West 42nd St., New York 36, N. Y.

### **PERMUTIT®**

rhymes with "compute it"

WATER CONDITIONING for BOILERS,
PROCESSING, PUBLIC and HOME WATER SUPPLIES

### NEW TYPE STURTEVANT AIR SEPARATOR

# Recovers Fines in Micron Ranges

Now the famous Sturtevant Whirlwind Air Separator, so widely used throughout industry for fast recovery of fines, has been specially designed to "pick-off" classified materials such as pigments, limestone fillers, plastics, oyster shells, etc., in micron sizes.

These highly efficient air separators select a continuously uniform product of desired fineness. Used in a closed circuit with grinding mills, they increase production, cut power costs.

Large feed opening, rugged construction, ease of adjustment, low power consumption assure economy of operation and minimum upkeep. Write for further information.

### STURTEVANT MILL COMPANY

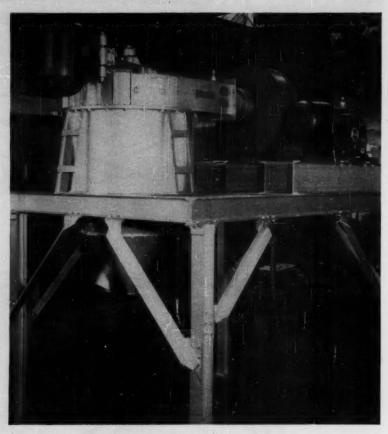
100 CLAYTON STREET BOSTON 22, MASS.

Designers and Manufacturers of:

CRUSHERS • GRINDERS • SEPARATORS

CONVEYORS • MECHANICAL DENS and

EXCAVATORS • ELEVATORS • MIXERS



### OTHER STURTEVANT EQUIPMENT



MICRONIZER ® GRINDING MACHINE
A fluid jet grinding machine, the Sturtevant Micronizer speeds reduction of materials to low micron sizes. These jet
mills are especially applicable in fields
where a particle size in microns is
desired.

Sturtevant Micronizer grinding machines are available in many sizes and capacities.



RING-ROLL MILLS

For medium and fine reduction (10 to 200 mesh), hard or soft materials. Very durable, small power. Operate in closed circuit with Screen or Air Separator. Open door accessibility. Many sizes. No scrapers, plows, pushers, or shields.



CRUSHING ROLLS

For granulation, coarse or fine, hard or soft materials. Automatic adjustments. Crushing shocks balanced. For dry or wet reduction. Sizes 8 x 5 to 38 x 20. The standard for abrasives.



BLENDER

Four-way mixing action assures a thoroughly blended product. Open-door accessibility permits easy cleaning. Available in many mixing capacities for 1/2-ton per hour and up.



Inner valves are machined on duplicating lathes to exacting standards. In this photo, master contour plate on lathe at (A) automatically duplicates the exact contour desired at (B) to form the inner valve.



Precision parts on 85&B Controls are manufactured to close tolerances. This lathe operator "mikes" inner valve for a final tolerance of .001". Other parts require tolerances of as little as 3/10,000".

# In Automatic Controls, BS&B Means..."Trouble-Free"!



Ample production facilities and stocks of material assure prompt deliveries on all standard items in the BS&B Controls line.

Whenever you buy an automatic control, you look for the finest and most dependable one you can find for the job from the standpoint of quality, precision, long life and "freedom from trouble."

Freedom from trouble is especially important, because once a control is installed in the line, any "down-time" caused by its faulty operation becomes very expensive—usually many times more expensive than the entire cost of the control itself.

That's why it always pays to specify and buy BS&B Automatic Controls! Because of their superior quality and their long trouble-free performance, they'll pay for themselves in almost no time!



A Sinusoidal waveform apparatus is used to check the accuracy and performance of a BS&B Type 1440 Pressure Control Pilot.



Proper treating and hardening of certain component parts of BS&B Controls in one of these precisely controlled electric annealing furnaces is just one of the important manufacturing operations which assures their high quality and long trouble-free service.





Every 85&B Control must pass rigorous operating tests in our modern hydraulic testing and experimental laboratory. In this view, valves in the line are under test pressures from hydraulic pumps in the foreground. Operator checks readings on the control panel for valve performance.

### BLACK, SIVALLS & BRYSON, INC.

**84 Sales Centers** 

Controls Division, Dept. 4-N6
7500 East 12th Street, Kansas City 26, Missouri

**40 Stocking Points** 



Mr. Design Engineer



Mr. Purchasing Director



Mr. Plant Superintendent

### BROWN FINTUBE DESIGN PROTECTS YOU AGAINST

### YOUR Occupational Hazard

• If it hasn't happened to you yet,-it will. Beware!

Some day the company is going to decide to make a new product at your plant. The "market analysis and research" department will assure you the maximum requirement is so many thousand gallons a week. You'll design the plant . . . buy the equipment . . . get on stream . . . and then two or three months later — BOOM!

The market analysis boys "played it safe". Now — based on "newly available statistics"— they need 20% to 30% more output than the plant you just finished can possibly produce.

If you equipped that plant with "bundle" type exchangers you are going to have to wait, while you design—and fabricate—and install all new units. And, what are you going to do with the exchangers you just bought? Throw them away after only two or three months use?

If you had used Brown Fintube Heat Exchanger Sections in that plant you would need only to add a few sections or change the series-parallel manifolding. You would be running on the new duty,—
or even an entirely different product—in just a
few days—with a minimum of new equipment—
and nothing to throw away.

That's what we call "flexibility". You can change from one duty to another any time you want. You can even dismantle an exchanger, ship the sections to one or three or four different plants, and put them right back in service again.

Many of the biggest, best known and lowest cost companies are keeping flexible by using Brown Fintube Sections throughout their plants. Why don't you play it safe too? Available with mild steel, stainless, alloy and non-ferrous fintubes—in standard sizes—for a wide range of capacities and pressures. Send for Bulletin No.

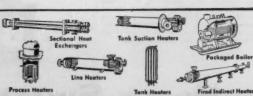
512. It gives full details. And plan on keeping your plant flexible with Brown Fintube Sections. They will really save you money!



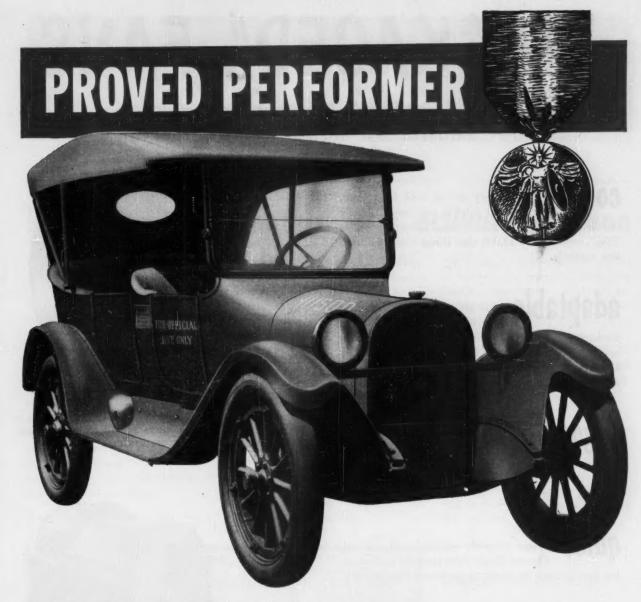


### Brown Fintube co.

360 HURON ST., Elyria. Ohio



Engineering and Sales Representatives: NEW YORK • BOSTON • PHILADELPHIA • PITTSBURGH • BUFFALO • CLEVELAND • CINCINNATI DETROIT • CHICAGO • ST. PAUL • ST. LOUIS • KANSAS CITY • MEMPHIS • BIRMINGHAM • NEW ORLEANS • SHREVEPORT • TULSA • HOUSTON • DALLAS DENVER • LOS ANGELES AND SAN FRANCISCO • Licensed Manufacturers: Brown Fintube (CANADA) LTD., ST. THOMAS, ONTARIO, CANADA BROWN FINTUBE (GREAT BRITAIN) LTD., BIRMINGHAM, ENGLAND • FRIEDRICH UHDE, GMBH, DORTMUND, GERMANY



This Dodge is the first passenger car used by the U. S. Army as a combat vehicle. It accompanied General John J. Pershing on the 1916 Mexican Expedition, and at one time was driven by a young lieutenant named George S. Patton! The old car still runs beautifully, 40 years since it saw the smoke of battle.

Outstanding service and time-tested dependability are points of pride with Esso Petroleum Solvents, too. These fine products have proved their worth over many years of use by customers who expect . . . and get . . . the highest quality for their money. Why not see for yourself? Specify Esso Petroleum Solvents next time you order.

### You can depend on Esso Solvents for

**MULTI-STORAGE AVAILABILITY**—water terminals in industrial centers.

modern Handling Methods — separate tank storage, pumping lines, tank cars and trucks are used in all handling operations. Prompt delivery to your door is assured.

**SOLVENCY** — Esso aliphatics and Solvesse aromatics cover both high and low solvency ranges.

CONTROLLED EVAPORATION—available in a wide range of evaporation rates with precise characteristics to meet your most exacting requirements.

FOR TECHNICAL ASSISTANCE — If you have a solvents problem or want further information on the specifications and characteristics of Esso Solvents—write or call our office nearest you. Our technicians will be glad to assist you.



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SOLD IN: Me., N. H., Vt., Mass., R. I., Conn., N. Y., N. J., Pa., Del., Md., D. C., Va., W. Va., N. C., S. C., Tenn., Ark., La.

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## "PACKAGED" FANS

Clarage V-belt Ready Units answer economically your smaller air handling requirements

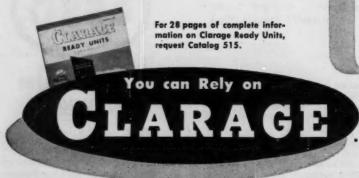
Ready to run, with fan, motor, and drive in one compact, easily installed assembly. 18 sizes, wheel diameters 9% to 32½", capacities to 12,000 cfm. Direct connected units also available.

adaptable Quickly adjustable in the field for various directions of air discharge. Slow speed, forward curved blade wheels or medium speed, backwardly inclined blade wheels available. Special units for handling corrosive gases and other special assignments can be provided.

Typical Clarage heavy-duty construction throughout. All working parts readily accessible, yet entire drive (except on largest sizes) is within frame of unit—an important distinguishing feature!

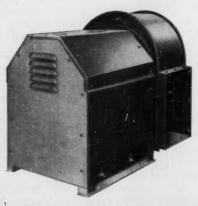
Quiet When properly selected and applied, Clarage Ready Units meet the most exacting requirements in respect to quietness of operation.

Capable Within their performance range, these units are unsurpassed for maximum air delivery at low power cost. You can select them with confidence for ventilation, exhausting, and other low pressure applications.





View of a standard Ready Unit as built in the medium-size range. Note how operating parts are shielded.



Ready Unit equipped with drive guard (at the end) and outdoor covers (on the sides) which provide complete weather protection.

CLARAGE FAN CO., Kalamazoo, Mich.

. dependable equipment for making air your servant

SALES ENGINEERING OFFICES IN ALL PRINCIPAL CITIES . IN CANADA: Canada Fans, Ltd., 4285 Richelieu St., Montreal



DARCO DIVISION
Chemicals Department ATLAS POWDER COMPANY, WILMINGTON, DELAWARE
ATLAS POWDER COMPANY, CANADA, LTD., BRANTFORD, CANADA

### Removing trace metals with activated carbon

Extremely small quantities of metallic impurities can cause a lot of trouble in many products. Picked up from reaction vessels or carried over from raw materials, these few parts per million may introduce toxic effects, off colors or tastes, or catalyze undesirable side reactions.

Activated carbon is usually a good bet for taking out traces of troublemakers. Commercial grades of carbon, however, will not adsorb ionically dispersed metals. Using ion exchange methods for this purpose, moreover, is a little like shooting a mosquito with a cannon.

A solution we have found effective is

to use activated carbon indirectly. The principle is to attach an adsorbable organic radical to the metal ion, and then use carbon to remove the resulting metallic organic complex.

Suppose your solution contains traces of iron or copper. Add mercaptobenzothiazole in about 25% more than stoichiometric proportions, and stir thoroughly. Then add about 1% by weight of the solution of high purity carbon. Darco G-60 is the grade we recommend for such uses. The carbon adsorbs not only the metallic complex but also the excess reagent, so there is no residual contamination of the product.

By a similar technique, traces of nickel can be removed using the familiar qualitative analysis reagent, dimethyl glyoxime. The xanthates can also be used for this type of application, since they are strongly adsorbed on activated carbon. Chelating agents, however, do not seem to work so well, probably because they are strongly soluble and thus not readily adsorbable.

Removing trace metals is only one of the hundreds of ways that you can use activated carbon in chemical processes. We'll be glad to consult with you on your specific problems, and to recommend grades of Darco and methods of application.



### Darco® meets high standards of purity

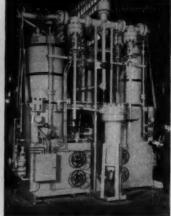
Darco activated carbons are all of vegetable origin. Most grades are made from Texas lignite. Darco G-60, the premium purity grade, is manufactured from high quality wood charcoal.

During the manufacturing process, Darco is thoroughly washed with acid, and then washed with water repeatedly until the carbon is brought substantially to neutrality. This process takes out extractable contaminants, and assures that treatment with Darco will not introduce impurities into the materials which it is intended to purify.

### DRYing...

one of your problems..
our full responsibility







Some Lectrodryers are built on a production-line basis, Most, however, are engineered and manufactured to suit each particular DRYing assignment.

Lectrodryer\* engineers have a wealth of DRYing experience. For 23 years they've been helping processors get rid of unwanted moisture in air, gases and organic liquids. That experience is at your command, at no extra cost.

Why design, build and gamble on the effectiveness of an unproven drier? No need for you to have the bother, extra expense and delay which so often develop in a new product. Lectrodryers have demonstrated their DRYing

ability. We have standard units which fit many requirements.

Let our engineers advise you on DRYing methods and equipment while the job is still on the drawing board. You may save at several points and, when the Lectrodryer gets onstream, you know it's going to work.

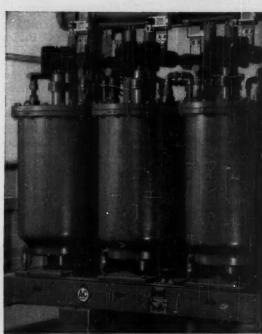
For DRYing help and free literature that will assist in your planning, write Pittsburgh Lectrodryer Corporation, 303 32nd Street, Pittsburgh 30, Pennsylvania.

LECTRODRYERS DRY
WITH ACTIVATED ALUMINAS

In England: Birlec, Limited, Tyburn Road, Erdington, Birmingham. In France: Stein et Roubaix, 24 Rue Erlanger, Paris XVI. In Belgium: S. A. Belge Stein et Roubaix, 320 Rue du Moulin, Bressoux-Liege.

LECTRODRYER

# Here's the Rectifier That Needs No Delicate Adjustments

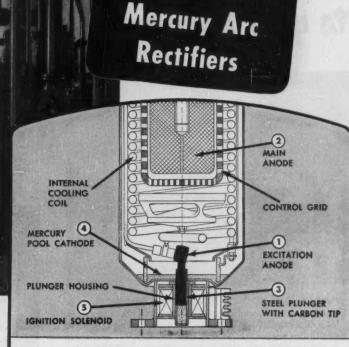


This 1000-kw, 6-tube excitron rectifier is typical of units used for heavy-duty service in many industrial plants.

LITTLE MAINTENANCE IS NEEDED with Allis-Chalmers excitrontype rectifiers. Excitation of the excitron rectifier is continuous, while other types of rectifiers require reignition 60 times a second.

Since it is more difficult to start a rectifier arc than to maintain it, the excitron rectifier is much less likely to lose excitation during operation. Momentary dips in supply voltage which are encountered in many supply systems have no effect on the continuous excitation arc.

Years of operation in hundreds of installations have proved the reliability and ease of operation of Allis-Chalmers mercury arc rectifiers. You can get complete information from your nearby A-C office. Or write Allis-Chalmers, Milwaukee 1, Wis.



### Unique Plunger Starts Continuous Excitation

The excitron tube has an excitation anode ① in addition to the main anode ②. With the excitation circuit de-energized, the steel plunger ③ floating in the mercury pool cathode ④ makes positive contact with the excitation anode (as shown).

When the excitation circuit is energized, the ignition solenoid 3 pulls the steel plunger 3 away from the excitation anode 1 and under the mercury pool cathode 2, thus drawing a dc arc and forming the cathode spot, which makes conduction of load current by the tube possible.

If power is interrupted the plunger will float up, contact the excitation anode and automatically re-establish the excitation arc when power is restored.

ALLIS-CHALMERS



# take a look at a loader that "Measures-Up" to your requirements



"MEASURES UP" GETTING LOAD because there is quick, positive crowding action — no slow, mushy starts. The Tractomotive Hydraulic Torque Converter Drive multiplies engine torque THREE TIMES . . . and there is the traction you need to take advantage of this extra torque with ample weight and big driving wheels. Result — heaping loads, fast!

"MEASURES UP" ON MANEUVERING Works in areas that would normally accommodate only lower capacity machines. Turning radius is only 11 ft at tip of bucket. You can go into a 10-ft bin from a 9-ft aisle! Bucket over drive wheels utilizes weight of load for greater traction... eases weight on rear steering wheels. Result—maneuvering time saved, production time gained!

# TRACTOMOTIVE TL-10 TRACTOLOADER

It's built as an industrial wheel loader from the ground up! Has years of HYDRAULIC TORQUE CONVERTER experience "under its bucket." Brings you the added advantages of a CLUTCH-TYPE TRANSMISSION which eliminates most gear shifting. Saves time maneuvering with short turning radius and bucket-over-drive-wheels design. Powered by the new Allis-Chalmers POWER-CRATER engine — high-octane performance on regular gasoline.

Has ¾-cu-yd bucket, 63-brake hp, weighs 11,400 lb! You get added versatility with interchangeable attachments — 1½-yd Light Materials Bucket, Lift Fork, Crane Hook, Backfiller Blade.

Ask your Allis-Chalmers Industrial Tractor Dealer for an on-the-job demonstration, Take a look at a loader that measures up to your requirements.



"MEASURES UP" DELIVERING LOAD There is fast getaway, fast delivery of load with the combined advantages of the Clutch-Type Transmission and Hydraulic Torque Converter Drive. A single lever controls backward and forward operation. Highest possible travel speed in selected gear range is automatically obtained through the torque converter. Result — shifting time saved, travel time gained, more trips made!



### SEE THE LATEST IN 4-WHEEL DRIVE EXCAVATOR-LOADERS, TOO!

### Tractomotive TL-12 Tracto-Loader

A combination of advantages makes it outstanding on excavating-loading . . . has a 1-cu-yd Tip-Back Bucket, 4-Wheel Drive, Hydraulic Torque Converter Drive, Clutch-Type Transmission and Rear Wheel Power Steering. But see for yourself . . . on your job. Ask your Allis-Chalmers dealer for a demonstration.

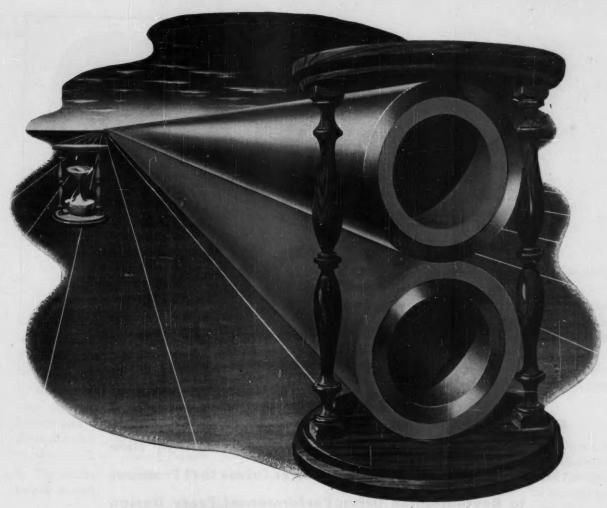
POWER-CRATER is an Allis-Chalmers trademark.

SOLD AND SERVICED BY YOUR ALLIS-CHALMERS INDUSTRIAL TRACTOR DEALER

### TRACTOMOTIVE

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TRACTOMOTIVE CORPORATION . DEERFIELD, ILLINOIS



### It's LAST cost that counts!

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In the long run you save money with Bridgeport Duplex Condenser Tubes! Resisting different types of corrosion, inside and out, they eliminate the need for frequent retubing and shutdowns... often improve heat-transfer characteristics... reduce maintenance costs substantially when the proper combination of metals is used.

Bridgeport Duplex tubes are available in many combinations to match your service requirements. For example: copper-steel, cupro nickel-lead, red brass-aluminum.

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Office for complete
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Technical Service.
Ask for your copy
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Offices in Principal Cities • Conveniently Located Warehouses Bridgeport Brass Company, Bridgeport 2, Connecticut In Canada: Noranda Copper and Brass Limited, Montreal



# FLEXIDYNE

### THE DRY FLUID DRIVE

DODGE of Mishawaka Announces An Entirely New Development in Industrial Power Drives that Promises to Revolutionize Drive Performance! Every Design Engineer and Plant Operating Man in America Will Want the Following Information.

Here are the facts on how easily Flexidyne handles difficult starting problems, and gives a *new* kind of protection against shock and overloads.

While new in the United States, this drive has already been proved in thousands of installations in Europe. Dodge has redesigned it to American standards and now makes its dramatic advantages available to all industry.

Flexidyne is a dry fluid drive. Its advantages over any other fluid-type drive are based on the fact that at normal operating conditions it does not slip.

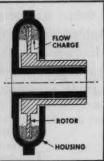
### WHAT IT IS

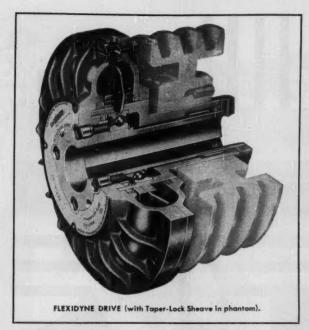
The Flexidyne Drive is made up of a housing, inside of which a rotor is free to turn concentrically. Between the two are fine particles of spherical steel shot, called the "flow charge," which acts very much like a fluid. The flow charge transmits power from housing to rotor.

This flow charge is easy to seal in, has a high density and can stand relatively high temperatures. The use of this flow charge makes possible a design that is simple, compact, economical, and gives outstanding new and different operating characteristics.

### HOW IT WORKS

- 1. The motor is connected to the housing, and starts it turning at no load.
- 2. The flow charge is thrown to the circumference of the housing, is compressed by centrifugal force, and revolves with the housing.
- 3. The rotor, connected to the load, is started and accelerated by the friction and wedging action of the revolving flow charge.





- 4. Rotor and housing reach identical speeds—the Flexidyne operates with ZERO SLIPPAGE between motor and load at normal running speeds.
- 5. Before overloads cause damage, the Flexidyne rotor slips relative to the housing, overcoming the friction and wedging action of the flow charge. A thermal switch (optional) automatically cuts the electrical circuit if an overload persists.
- 6. The amount of the flow charge determines the torque capacity.

### WHAT IT DOES

The Flexidyne gives you the exact starting torque you need, for anything from the smoothest to the fastest start. Once the load reaches normal speed, there is zero slip, giving 100% efficiency. Also, it provides accurate overload protection, as it can be set to slip at any desired load. During starting and overload periods the current draw is at a minimum because with the standard Flexidyne setting the motor is never pulled down to less than 90% of synchronous speed.

All this is due to Flexidyne's completely new principle, which produces constant torque for a given input speed, regardless of the percentage of slip between the rotor and housing (which occurs only during starting or overload).

The Flexidyne is simple to select off the shelf. Each size has a standard horsepower rating and yet it is only a matter of minutes to vary the flow charge to give you your own tailor-made torque to suit the job.

With Flexidyne you get uniform performance regardless of changes in the surrounding temperature.

The Flexidyne has very long life and practically negligible maintenance. Its simplicity guarantees its

dependability. Gas and diesel engines also benefit from all Flexidyne advantages.

Aside from Flexidyne's low first cost, low maintenance, and top efficiency, it permits the use of smaller, cheaper motors and controls with greatly reduced current demands and improved power factor. Its smoother starts and gentler overload protection avoid breakage and reduce maintenance on drives, gears, bearings and driven machinery.

### FLEXIDYNE COUPLINGS

Two lines will be available—Flexidyne Drives, for convenient mounting directly on motor shafts and adapted for Dodge Taper-Lock Sheaves, and Flexidyne Couplings with Taper-Lock Bushings, for straight line drives. Several thousands of these units of French design, in capacities ranging from fractional to thousands of horsepower, are now in use in Europe. Dodge will first offer — from stock — four sizes rated at 3 to 30 hp at 1800 rpm. Other sizes will follow.

Write now for special bulletin, delivery dates and application information.

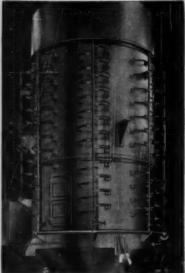
DODGE MANUFACTURING CORPORATION 200 UNION STREET, MISHAWAKA, INDIANA

CALL THE TRANSMISSIONEER, your local Dodge Distributor. Factory trained by Dodge, he can give you valuable assistance on new, cost-saving methods. Look for his name under "Power Transmission Machinery" in your classified telephone directory, or write us.









"Buffalo" Hydraulic Scrubbing Tower



"We were stumped with a problem of coke breeze discharge. Even after cyclone separation, it was heavily loaded - thick and black. To make matters worse, the contaminant was too abrasive and hot for ordinary equipment to handle! Then we talked to a "Buffalo" engineer. He recommended a unit "Buffalo" just recently developed a Hydraulic Scrubbing Tower. It cleans by wet centrifugal scrubbing. The effects of heat and severe abrasion are overcome. It doesn't clog - needs very little attention. And its collection efficiency is so high that our stack discharge is harmless and almost colorless. When you consider the improved 'neighbor relations' and the simplicity and economy of operation, our "Buffalo" Hydraulic Scrubbing Towers have paid for themselves many times over."

### KNOW-HOW PLUS EQUIPMENT FOR YOUR AIR CLEANING PROBLEMS!

"Buffalo" units and "Buffalo" experience cover the entire range of today's specialized air cleaning applications. Why not call on these facilities for the best results on your problem - for the famous "Q" Factor\* Performance that plants everywhere are enjoying.

\*The "Q" Factor - The built-in Quality which provides trouble-free satisfaction and long life.

### BUFFALO FORGE COMPANY

501 BROADWAY

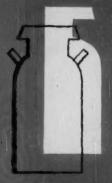
BUFFALO, NEW YORK

PUBLISHERS OF "FAN ENGINEERING" HANDBOOK Canadian Blower & Forge Co., Ltd., Kitchener, Ont. Sales Representatives in all Principal Cities :...

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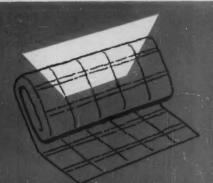
# ask the man from Loyne anything about water... the irreplaceable essential in modern production DID YOU KNOW THAT IT TAKES:



5 gallons of water to produce
1 gallon of milk



10 gallons of water to produce 1 gallon of gasoline

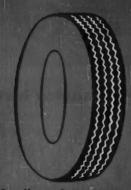


75 gallons of water to produce
1 pound of fabric



80 gallons of water to produce

1 KW hour electricity



300 gallons of water to produce
1 pound of synthetic rubber



65,000 gallons of water to produce 1 ton of steel

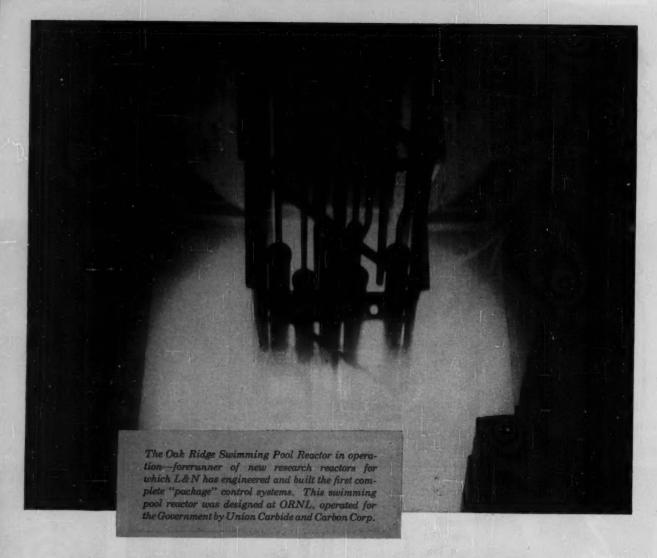
The man from Layne knows most about water . . . how to develop and apply it to serve best the needs of agriculture, industry and municipality.

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A new concept in nuclear reactor instrumentation...

# L&N "Package" Control Systems

Nuclear reactors for private enterprise are no longer classified as "things to come." College research reactor No. 2—privately constructed, owned and operated—will be in service shortly at Pennsylvania State University. And No. 3, the University of Michigan Reactor, will follow closely.

Both the Penn State and Michigan Reactors will be completely controlled by L&N "package" reactor control systems, the first such package controls ever engineered—another "first" for Leeds & Northrup Company, pioneers in precision control; builders of the world's first electronic recorder.

The package concept involves far more than control instrumentation. It includes design services, engineering consultation, individualized fabrication of panels or cubicles, and more. It's an approach possible only by a group with L&N experience—

dating from activation of the original Chicago Pile—using standard L&N instruments which can control reactors routinely, without the elaborate customizing so often required when velocity-feedback servo systems are used.



Package reactor control in its various aspects is described in our new brochure, "L&N Control Systems for Nuclear Reactors." We'll be glad to send you a copy. Just write to Leeds & Northrup Company, 4916 Stenton Ave., Philadelphia 44, Penna.



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from by-product gases and fluid flows?

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### 1

36-page BROCHURE explores the broad possibilities of low-temperature processing. Write for a free copy.

### EXAMPLE:

Hydrocarbon
Separation
from
Refinery and
Coke Oven
Gases

Ammonia Synthesis Gas

OXYGEN NITROGEN NYDROGEN

Methane,

Oxygen,

Carbon Monoxide

Nitrogen

Hydrogen.

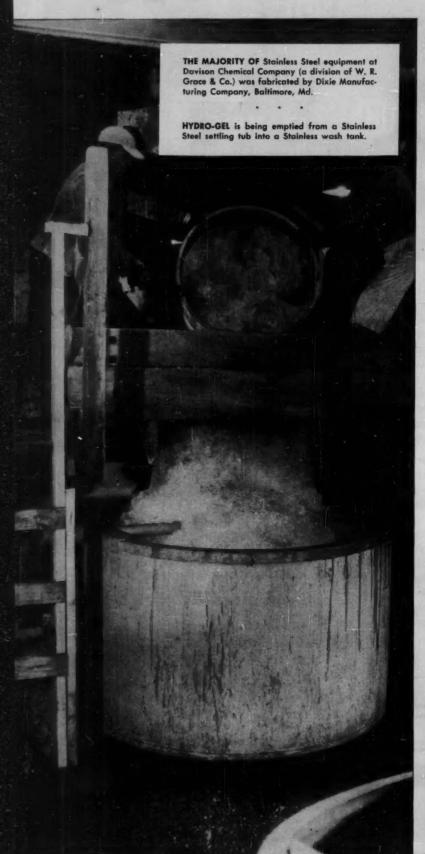
-459 6°

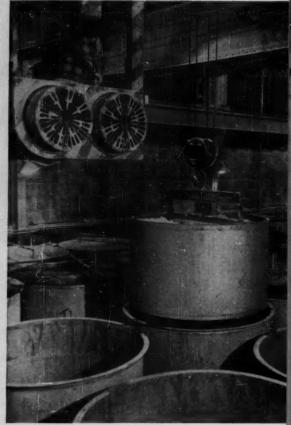
**Boiling Points, Fahrenheit** 

Air Products

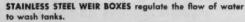
Specialists in Low-Temperature Processing

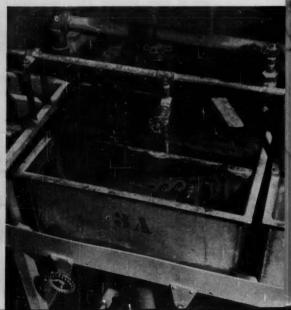
# Maintenance is lower and





WASH TANK is lowered into a larger Stainless Steel vessel for the washing operation.





# clean-ups are faster

# when hydro-gel is processed in Stainless Steel tanks

• By REPLACING wooden settling tubs and wash tanks used in hydro-gel processing with Stainless Steel equipment, Davison Chemical Company, Division of W. R. Grace & Co., Baltimore, Md., has lengthened service life and made clean-ups quicker and easier.

In settling tubs, where hydro-sol solidifies into hydro-gel, Stainless Steel is replacing wooden tubs. The wooden tubs lasted six months to a year while Stainless is expected to last indefinitely. In addition, material doesn't adhere to Stainless tubs and time-consuming scraping and cleaning is eliminated.

Stainless Steel also has replaced metal-lined wooden tubs in the washing operation that follows. Stainless Steel's light weight permits one crane operator to handle these tubs where a crew of three was necessary to palletize the heavier wooden tubs. And the wooden tubs required

maintenance on a weekly basis.

Water for the washing operation comes to the wash tanks from a Stainless Steel pH tank through one of six Stainless Steel weir boxes. The plant also makes extensive use of Stainless in piping and pumps.

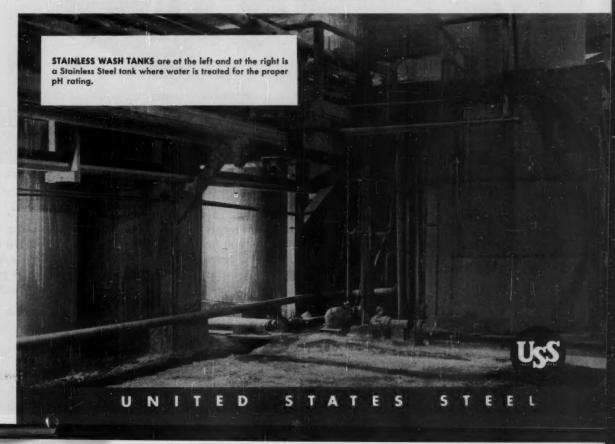
Stainless Steel offers so much—corrosion resistance, long life, ease of cleaning, freedom from contamination—that it is a key material in almost any type of chemical processing operation. Make full use of its economy and when you do be sure you get service-tested USS Stainless Steel.

SEE The United States Steel Hour. It's a full-hour TV program presented every other week by United States Steel. Consult your local newspaper for time and station.

### **USS STAINLESS STEEL**

SHEETS - STRIP - PLATES - BARS - BILLETS
PIPE - TUBES - WIRE - SPECIAL SECTIONS

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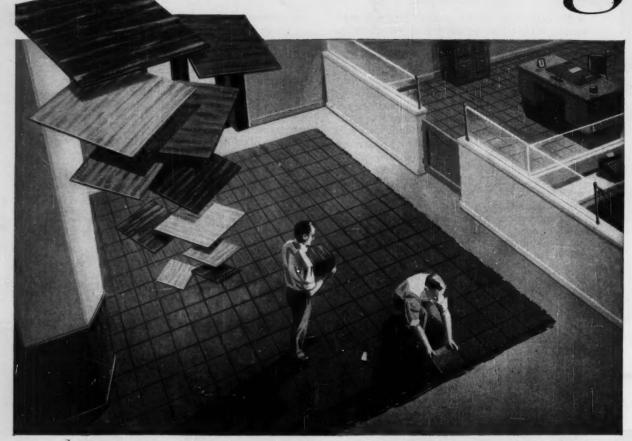


EXON: each resin engineered for a specific problem

## EXON 468

specifically for

# flooring



Higher bulking density of EXON 468 increases the banbury output 10 to 25%! It makes processing easier, since it permits fast fusion at reduced temperatures.

A superior resin in every respect, EXON 468 offers good heat and light stability, high thermoplasticity, compatibility with conventional vinyl plasticizers, stabilizers and pigments. Used as the base resin in vinyl asbestos floor tile formulations, EXON 468 provides new production economies — and superior end products.

For suggestions on developing new products, or improving established ones with EXON 468—or for complete information or technical service on the growing line of versatile EXON resins, contact:



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FIRESTONE PLASTICS COMPANY, POTTSTOWN, PA., DEPT. 28P DIVISION OF THE FIRESTONE TIRE A RUBBER COMPANY





Glycerine is a liquid. There are no bags to lift, no fines. As easily as pushing a button, Glycerine can be piped into your kettles. You can measure it either by volume or by weight. And if you want, it's easy-and safe-to add more Glycerine during cooking.

Glycerine has other important advantages in making alkyds, too:

- Its simple molecular structure makes cooking easier.
- Its low MW/Hydroxyl ratio makes a wide range of resin properties economically feasible.
- Its chemistry has been thoroughly evaluated. Methods are perfected and literature abundant.

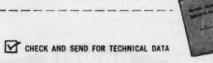
As year after year proves . . . nothing takes the place of Glycerine.

This balanced group of properties keeps



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16-page booklet on Glycerine properties and applications

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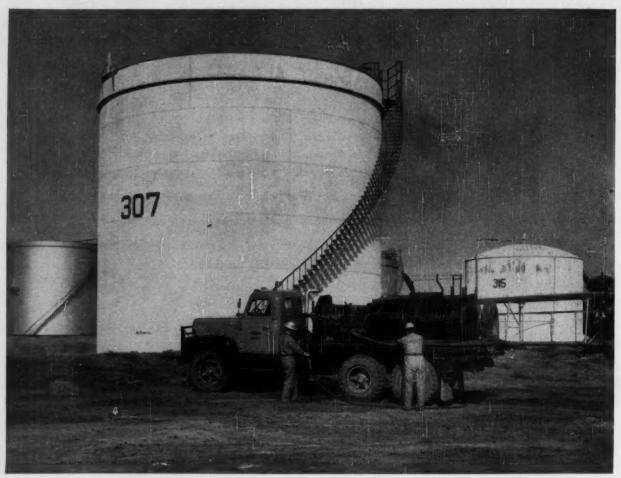
### **6 TANKS CLEANED IN 5 HOURS**

# Chemical cleaning by DOWELL prepared 216,000-gallon oil tanks for conversion to sulfuric acid storage

A steel company wanted to convert six 216,000-gallon tanks from fuel oil and gasoline storage to sulfuric acid storage. It was necessary to remove oil and tar film from the inside walls and ceilings of these tanks.

Dowell engineers, using special high-pressure hoses and nozzles, sprayed thickened chemical solvents over all internal surfaces from the tank floor. No scaffolding was required. The thickened solvents clung to the tank walls during the cleaning process. The entire surfaces of all six tanks—including seams, rivets and braces—were cleaned in only five hours.

Whatever your cleaning problem—pipe lines, boilers, process equipment, water wells—take it to Dowell. Their engineers have the experience, materials and equipment to help you cut cleaning costs—keep up production. Get in touch with the nearest of over 130 offices or write direct to DOWELL INCORPORATED, Tulsa 1, Oklahoma, Dept. F-33.



Dowell engineers prepare solvents based on the type of deposit to be removed. They furnish all necessary pumping and control equipment. And they apply the chemicals according to the technique demanded by the job: filling, spraying, jetting, cascading or vaporizing. Dismantling is held to a minimum.

chemical cleaning service for industry





Toledo Edison Company reports on its use of Autopositive-

### "One saving after another since 1947"

Shortly after Kodagraph Autopositive Paper was introduced, the Toledo Edison Company, Toledo, Ohio, began exploring its possibilities for engineering drawing reproduction.

Here was a revolutionary photographic intermediate paper which produced positives directly from positives—no negative step. It could be exposed in standard print-making equipment... processed in standard photographic solutions. Entire operation in ordinary room light, too. Jobs which had been difficult and costly became easy and economical—Kodagraph Autopositive Paper costs only a few cents a square foot. Some typical savings at Toledo Edison which you can duplicate are listed here.

☐ Old prints and intermediates reclaimed. No time lost retracing. Autopositive Paper strengthens weak line detail, cleans up backgrounds. Toledo Edison now can get intermediates which have dense photographic black lines on an evenly translucent paper base. Original quality or better!

☐ Opaque originals no problem. Many of Toledo Edison's forms, charts, operating maps, etc., are on opaque stock—some two-sided. Data is added to these in pencil or by typewriter. Then Autopositive reproductions are made and used to produce the direct-process prints needed for distribution. The 1954 Annual Budget, for example, was reproduced in this manner. Autopositive saves time and dollars for all departments.

☐ Print-making simplified. Toledo Edison runs Autopositive intermediates at uniform, practical speeds in its direct-process machine . . . gets sharp prints time after time. Autopositive lines do not smear, smudge, or lose density.

☐ Drafting shortcuts. An Autopositive print is made of a drawing which has to be altered. The obsolete detail is eradicated or scissored out, and another Autopositive is made. New design is then added, and the job is completed without redrafting.

☐ Photo-lasting file copies. Toledo Edison also finds that Autopositive intermediates will not turn yellow or become brittle... are ready to produce sharp, legible prints whenever needed.

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Position

Shows all the ways you can save with Kodagraph Autopositive Paper. 

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### TYPE 950 HANCOCK 800# STEEL GATE VALVES

Outside Screw and Yoke, Sizes: 1/4" thru 2"



Install a Hancock 800# Bolted Bonnet Steel Gate Valve in your piping system and prove for yourself why this valve sets the pace in dollar-for-dollar service and value. Hancock Gate Valves have cut valve costs in hundreds of refineries, chemical and petrochemical plants and other installations . . . have proved themselves the best, most economical valve for process and power piping systems. They can mean similar savings for you.

To provide such service and value, Hancock Gate Valves combine two big advantages: specially selected materials for extraordinary long wear under difficult operating conditions and an exclusive design for positive, maintenance-free performance. Features include highly accurate guiding to prevent wedge dragging and consequent leaking, a wedge of "500 Brinell" stainless steel, seat of 11-13% chrome stainless steel, plus a spiral-wound gasket and swing bolt and nuts of stainless steel.

When Hancocks go in, valve costs go down.



GET THE WHOLE STORY about these 800# Hancock Steel Gate Valves from your local Industrial Supply Distributor. His knowledge of valves and their correct application can also save you time and money. Phone him today.

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A product of MANNING, MAXWELL & MOORE, INC. Watertown 72, Massachusetts

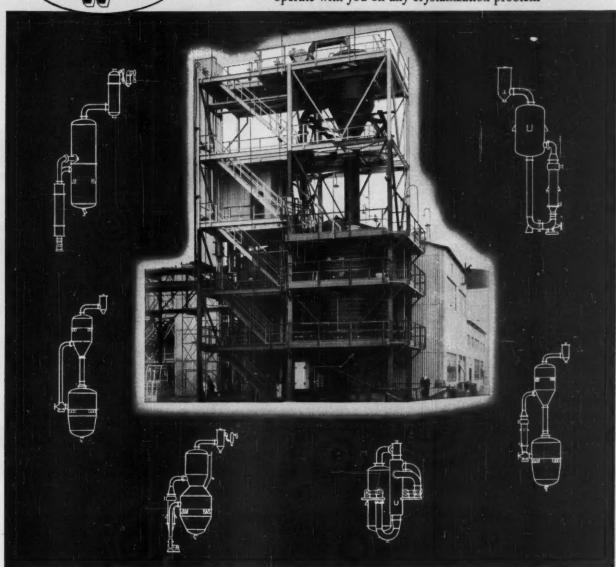
MAKERS OF 'AMERICAN' INDUSTRIAL INSTRUMENTS, 'ASHCROFT' GAUGES, 'CONSOLIDATED' SAFETY AND RELIEF VALVES, 'AMERICAN-MICROSEN' INDUSTRIAL ELECTRONIC INSTRUMENTS, Stratford, Conn. 'CONSOLIDATED' SAFETY RELIEF VALVES, Tulsa, Okla. AIRCRAFT CONTROL PRODUCTS, Danbury, Conn. and Inglewood, Calif. "SHAW-BOX" AND 'LOAD LIFTER' CRANES, 'BUDGIT' AND 'LOAD LIFTER' HOISTS AND OTHER LIFTING SPECIALTIES, Muskegon, Mich.

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### **CRYSTALLIZERS\* OF ALL TYPES...**

Know-how, combined with laboratory and pilot plant equipment, plus the finest manufacturing facilities enable us to offer the designs best suited for specific purposes.

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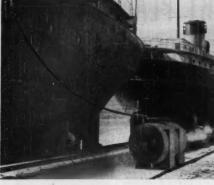
\*Patented and Patents Pending



### Here's MASS-HANDLING of bulk

What you see above is a Dempster-Dumpster serving one of its detachable containers. Multiply this simple pick up, haul and dump operation by scores of steel containers built to meet your requirements for handling waste or salvable materials, raw and finished products, fluids including acids, combustibles, dusty materials, etc. You have, then, mass-handling of bulk materials with one truck and one man!







Tilt Type Container is handling filter dirt at a plant in Illinois. Note container is equipped with casters and placed under chute, through which the filter dirt passes directly from presses. As each container is filled, it is replaced with an empty one.

Three heavy duty Drop Bottom Type Containers, shown below, are loaded with cast iron fittings from conveyor at plant in Birmingham. Dempster-Dumpster picks up each container when loaded and hauls the finished products to shipping department.

Tank Type Container is being filled with used oil from a ship. Time required to haul loaded container to reclaim station, drain and return for refilling—10 minutes. Time cycle of the former method using conventional barrels—60 minutes.

Here's another example of the many types of waste materials handled by this system. The Skip Type Container shown below is located under hydropulper at a paper plant. Picture was shot while container was being filled with rope was:e sludge.

A loaded Apartment Type Container, equipped with roller bearing casters, is being rolled to outside of this plant building. Dempster-Dumpster will pick it up, haul to disposal area, dump the refuse and return empty container for refilling.

Waste materials are loaded into these Universal Containers at a food plant warehouse. Containers have lids in top, as well as a door in each end, which are opened to make deposits, then closed, sealing materials in container.







### materials with one truck...one man!

A FEW OF THE HUNDREDS of containers available are shown above in actual service. They are built in capacities up to 21 cu. yds.—several times the capacity of the average dump truck body. One Dempster-Dumpster, operated by only one man, the driver, serves scores of big detachable containers, one after another—handling materials of every description. It's like having one truck with scores of bodies!

Records of performance in dozens of installations prove beyond question that savings are tremendous! The Dempster-Dumpster System cuts costs of equipment and operation. It is common knowledge that one Dempster-Dumpster will perform the work of several conventional trucks, reducing investment ac-

cordingly. This system eliminates standing idle time and re-handling of materials. Once placed in these containers, materials remain there until hauled to destination. Efficiency, sanitation and good plantkeeping are big advantages. Materials to be transferred or disposed of are constantly being placed in the containers as they accumulate. Containers for handling refuse are fire-proof, rat-proof and scavenger proof.

With no obligation on your part, our engineers will be glad to make a comprehensive fact-finding survey to determine the cost-cutting possibilities of this equipment in your plant. Write us for complete information today! Manufactured exclusively by Dempster Brothers, Inc.

**DEMPSTER BROTHERS** 

265 Dempster Building, Knoxville 17, Tennessee

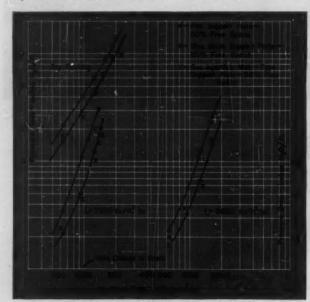
# WEIR-TYPE SUPPORT PLATE\* IMPROVES PERFORMANCE OF ANY DUMPED TOWER PACKING

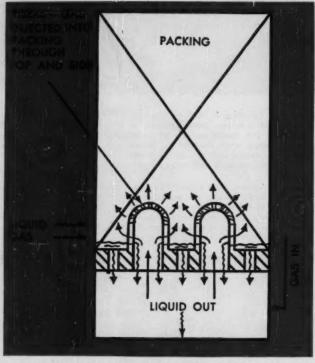
The lower pressure drop expected from a high bed voidage can be quickly dissipated by restrictions to gas and liquid flow, set up by a limiting free area in the packing support plates.

Conventional flat ceramic support plates have an actual free area of 20-30%. Effective area, however, is usually much less, because dumped packings, particularly in the smaller sizes, tend to block the openings in the plates.

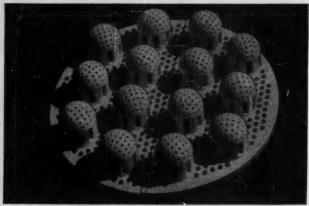
To approximately equal the voidage ordinarily encountered in a packed bed, a support plate must have a free area better than 50%, under actual operating conditions.

The weir-type support plate, in every size from 12" diameter up to 60" diameter, has better than 50% free area. Its unique, patented design minimizes any tendency of the packing to block the plate openings. Its high mechanical strength provides ample support, and, of course, its chemical porcelain body is completely acid-and-corrosion-resistant throughout (except for hydrofluoric acid and hot caustics).





In operation, the gas is actually injected or distributed into the column through the perforated hemispherical caps and through the upper portion of the slots in the risers. A major portion of the liquid ordinarily leaves the column through the openings in the base plate, but should these openings prove insufficient, and a slight head form, the overflow will escape through the bottom half of the slots in the risers.



Write for New Bulletin—
on Weir-Type Support Plates
\*U. S. Stoneware patent pending

THE UNITED STATES STONEWARE CO.

Process Equipment Division
NEW YORK CHICAGO

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# JUNE 1955 Chementator

- Titanium tetrachloride from Columbia-Southern's just-begun plant at Natrium, W. Va., is definitely slated to go to Electro-Met's 7,500-ton-per-yr. sponge plant due to start up at Ashtabula, Ohio, in mid-1956. Electro-Met will supply ore to Columbia-Southern.
- Ethylene markets on the East Coast are attracting still another producer. Tide Water Oil has been eyeing them, now Oronite Chemical plans to build a New Jersey ethylene plant to utilize an entirely new process. Most likely location: Perth Amboy.

### New chlorine cell is real space saver

For 60,000 amp. capacity, a bank of new chlorine-caustic cells designed by Vittorio de Nora of Italy takes a floor area just 50 in. long and 3 ft. wide. And the whole bank is only 3 ft. high.

Individual cells—3,000 amp., but just 2-in. thick—stand vertically, but are stacked horizontally much as a plate-and-frame filter press. They combine a porous diaphragm with mercury flowing down a vertical metal support (the cathode).

To visualize a cell (side view), draw five parallel vertical lines. The middle one represents a 3 ft. x 3 ft. steel wire screen of about 10 mesh. (You see just one 3-ft. edge.) Mercury flows down and completely covers both sides of the screen. It's distributed from a pipe running along the screen's top length. The two intermediate lines represent porous plastic diaphragms; the two outside lines are graphite anodes. Distance from graphite to graphite is 2 in.

Minimum space is not the only advantage cited. Compact arrangement requires less mercury inventory—40% less than present mercury cells.

The new cell also uses—to advantage—a different amalgam concentration. Entering at the top the mercury contains 0.3% sodium, leaving the bottom, 0.4%. Other mercury cells charge sodium-free mercury, end up with 0.1% sodium. Because of the higher sodium level De Nora gets by with a smaller decomposer. He also claims to get a high concentration of caustic more readily.

There is one potentially serious drawback, though—anode-to-mercury distance can't be adjusted to compensate for the slight anode consumption that occurs in any mercury cell. However, De Nora says his 16,000-amp. pilot cell in Milan has operated for periods of nearly a year without anode adjustment and he recommends simply changing the anode every six months. The graphite is in thin sections so cost would be slight.

De Nora is now looking for someone to venture out commercially, preferably in Europe because of proximity to the pilot plant. But the field is wide open here, too, and Monsanto has been designated to handle U. S. sales.

### Phillips polyethylene leaps ahead

Details are beginning to leak out on Phillips Chemical's much-vaunted low-pressure polyethylene process. Coincidentally Phillips has decided to build a commercial plant at Pasadena, Tex., using the process, plus a 145-million-lb.-a-year ethylene plant at Sweeney, Tex.

What's more, contrary to previously stated policy, Phillips now expects to license the process to other companies.

First published insight into how Phillips' process works comes from a recently issued Belgian patent (530,617). Innocently titled "Improvement relative to the polymerization of olefins," this patent claims a new polymerization catalyst, a way to make it and a process for producing new gummy

(or resinous) and solid polymers from olefins. Though most of the examples cited refer to propylene polymerization, manufacture of polyethylene is definitely covered.

Without doubt, the new catalyst—chrome oxide (highly hexavalent) on a 90% silica-10% alumina support—keys the process. Says Phillips: "The presence of chrome oxide is absolutely essential for the production of polymers with high molecular weight which are gummy and solid."

And the company has good reason for being so positive, for it tried just about every likely metal oxide (over 20 of them) and only chrome gives a semisolid polymerization product with propylene under the reaction conditions. Yield is high, too. Most of the other oxides give liquid polymers, but yields are generally very poor.

According to its patent, Phillips polymerizes in liquid phase with a hydrocarbon diluent—any C<sub>3</sub>—C<sub>12</sub> paraffin. Extended tests of diluents from propane through iso-octane showed that conversion goes up as molecular weight of the diluent increases. Only pressure needed for the process is to keep the diluent liquid at the operating temperature—preferably about 500 psi. Preferred temperature range for polymerizing ethylene is 275–375 F.; actual temperature is probably about 310 F.\*

Phillips claims these important advantages for its polyethylene: melting point 235–261 F., against 228 F. for best competitor; doesn't soften in steam sterilization as hot as 250 F.; average density 0.952, against 0.936 for best competitor; hardness "D" (Shore) 62, against 48 for best competitor. These properties are expected to create big demands for it in packaging film, nonbreakable bottles, flexible and rigid pipe, molded articles, wire and cable insulation and laminates with paper and other films.

Not 200 F, as reported here last month. Propylene and higher olefins are polymerized at about 200 F.

### Clearing skies for food additives?

After years of argument, opinion finally seems to be crystallizing on what type of law is needed to cover introduction and use of food additives. Though there's been no compromise between the two major factions, a bill has finally gotten into the legislative mill that may be close enough to "middle ground" to satisfy most people.

The bill is H. R. 5927, introduced by Rep. A. L. Miller of Nebraska, who already has his name attached to last year's pesticide amendment to the food and drug laws.

Historically, such organizations as the Millers' National Federation, American Baking Assn. and

American Meat Assn. have favored strict, new-drug type of approval of chemical food additives. Their bill was introduced by Reps. Priest and O'Hara. On the other side have been such groups as the Manufacturing Chemists' Assn. favoring prior notification of the Food and Drug Administration and submission of toxicological and other test data. FDA would then have the opportunity to stop introduction of the additive by going to court.

Under Miller's proposal, a company wanting to market an additive would ask FDA approval; if denied, the firm could either notify FDA that it was going to market anyway—and FDA could go to court to stop it—or the firm could ask that the case go to a government-medical-industry panel.

If only FDA or the panel found the material unsafe, and the case went to court, FDA would have to prove the additive harmful; if both FDA and the panel found it unsafe, the manufacturer would have to prove his material not harmful.

Hearings on these bills are set for June. So it's possible that the full House, if not the whole Congress, may have a chance to vote on the subject before this year's adjournment.

### Glycerine coming via new route

Starting with refinery products—probably propylene—and going through three all-new syntheses, Shell Chemical has devised an entirely new way to make glycerine. First of three plants needed is already under way at Norco, La.

All Shell's saying now is that the Norco unit will turn out 30 million lb. a year of nonelectrolytic hydrogen peroxide; later a second plant will be built to make acrolein; finally, peroxide and acrolein will be combined in a third plant to produce glycerine. Some peroxide and acrolein will also be sold as such.

Speculation is rife as to what processes are involved. One very likely setup, on which Shell refuses to comment, is all based on propylene. Peroxide would be made by liquid-phase oxidation of propylene-derived isopropanol (British patent 708,339). An important coproduct is acetone. Acrolein would be produced by direct catalytic oxidation of propylene (U. S, 2,451,485). Finally, peroxide and acrolein would react to give glyceraldehyde, which would be hydrogenated to glycerine.

If this is Shell's technique, acetone output would hit pretty close to 50 million lb. a year, a big slug to put onto an already spotty market

(Continued on page 108)



To solve a problem, first get to the center of it; and that's just what the engineers of Celanese and Delta Engineering did at the Celanese Corp. of America's Summit, N. J. research lab.

The nub of the problem called for controlled temperatures to be made available throughout the building for research and pilot plant work. The solution centers on a p-k brine storage chiller centrally installed in the basement. Around it is the system of the closed-circuit type, composed of compressor, pumps, brine make-up and mixing tanks, with all instruments and controls mounted in a centrally located control panel.

Elimination of the conventional, open roof tanks means a clean system, while careful integration of units ensures ease of maintenance. This compact p-k chiller installation, requiring only minimum insulation and floor space, is factory assembled in the 780 gal. brine storage tank. From here, brine is circulated throughout the building at -15°F. to -10°F., with Freon 22 used as the cooling medium.

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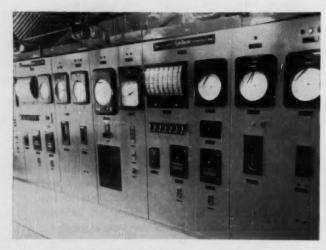
101 Park Avenue, New York 17 . Railway Exchange Building, Chicago 4 . 1700 Walnut Street, Philadelphia 3 . 96-A Huntington Avenue, Boston 16 . and other principal cities.

Aerial view of acid section at Weed Heights, Nevada. FluoSolids System is in foreground . . . contact acid plant in right rear.

# Fluidization NEW TOOL FOR THE PROCESS INDUSTRIES

You've heard a lot about fluidization in the last ten years and the changes it has brought about in the petroleum industry. But did you know that new applications for fluid bed techniques are still turning up in many non-catalytic fields as well? A good case in point is the installation shown on these pages.

### Anaconda First to Roast Low Grade Sulfur



This completely instrumented FluoSolids control panel gives a graphic picture of the entire operation.

The world's first commercial installation for producing SO<sub>2</sub> gas from low grade sulfur ore is now on stream at Anaconda Copper Company's plant at Weed Heights, Nevada.

The FluoSolids System that makes this possible includes four 18 ft. dia. Reactors plus other Dorr-Oliver equipment and auxiliaries. SO<sub>2</sub> gas is sent to a 450 TPD contact acid plant which supplies all acid requirements for leaching 11,000 tons of copper ore per day.

Feed to the system is 650 to 750 tons per day and gas production 26,000 to 30,000 C.F.M. Gas strength averages 8 to 12% representing a sulfur recovery of 98%. Unusual? Yes, because this is the first time that low



### Ore to Produce SO2 for Acid Manufacture

grade sulfur ore could be recovered as SO2 . . . economically. Here's how the system works ... ore averaging 28% total sulfur is crushed to 10 mesh and fed dry to the Reactors which operate in parallel. Once ignition temperature is reached no extraneous fuel is needed. Ore is simply fed in at the design rate, latent heat in the bed immediately brings it to ignition temperature, and the fluidizing air oxidizes the sulfur to SO2. Shutting down is a matter of minutes. And because the fluid bed stores sufficient heat, roasting can be started again after as much as 72 hours without adding additional fuel.

For Further Information - Chances are you don't need 450 tons of sulfuric acid a day. But if there's a step in your flowsheet where intimate contact between solids and gases is essential, fluidization should be investigated. As licensee in all non-catalytic, non-hydrocarbon fields, Dorr-Oliver has continually expanded the applications of this new technique since 1944. We will be glad to work with your research and development department, run pilot plant tests at our Westport Laboratories, or cooperate in any other way necessary to insure a realistic evaluation of fluidization in terms of your process. Just drop a line to Dorr-Oliver Incorporated, Stamford, Conn., or in Canada, 26 St. Clair Ave. East, Toronto 5. No obligation of course.

FluoSolids is a trademark of Dorr-Oliver Incorporated. Reg. U. S. Pat. Off.



(see Chem. Eng., March 1955, p. 262). But as a byproduct, production costs charged to it might be very low, giving Shell a real price advantage.

Most important, though, is that Shell has a new glycerine route that must have economic advantage over its original process. And implied, certainly, are cheaper acrolein and hydrogen peroxide. It adds up to quite an accomplishment.

### Transistors move into industry

In the past 18 months General Electric reports 11 transistor rectifiers installed, totaling over 6,000 kw. The biggest is delivering 40,000 amp. at 24 v. with 94% efficiency. And in July one will start delivering 30,000 amp. at 65 v. Both electrolyze water. Main advantage of germanium diodes over selenium or copper oxide rectifiers is high efficiency at low voltage.

### Chemicals look to atomic fission

Now in the talking stage is a project that could be the vanguard of a new type of atomic development—designing reactors not to make steam for electric power generation, but to produce high-level heat directly usable in chemical processing.

Current discussions initiated by the Bureau of Mines with the AEC center on production of synthesis gas from coal and steam. If BuMines' proposal is accepted AEC would expect to build a nuclear reactor to produce temperatures between 2,000 and 3,000 F. Steam and pulverized coal would be injected in a pipe running through the reactor.

Biggest problem facing researchers is not reactor design, but materials of construction for the reaction pipe—must have good high-temperature stability, good heat transfer characteristics and good resistance to nuclear radiation.

Silicon carbide appears to meet all these criteria and is a good bet. But it poses some problems, too: It must resist erosion by the moving coal; it must resist corrosion from molten coalslag particles; it should have low gas permeability so reaction can run at pressures close to those at which synthesis gas is used. The Bureau will test these points at Morgantown, W. Va., by electrically heating a fabricated carbide tube, duplicating desired intra-reactor temperatures.

Costs are a big point in the Bureau's proposal because there's a good chance that atomic heat would be cheaper than present syntheses in which costs to get to the needed reaction temperature run about 9¢ per 1,000 cu. ft. of gas made. But most important for the long haul is the hope of

pioneering the use of nuclear energy to power many high-temperature chemical reactions that aren't economic today.

### Mix your own explosives and save

That's what Maumee Collieries Co. of Terra Haute, Ind., does with Akremite—a patented new explosive—and savings are big. Cost to licensed users who mix their own, including raw materials, mixing, packaging, delivery and royalties, should be about half the averaged cost of delivered fixed explosives.

Akremite is simply a mixture of inexpensive, commercial-grade ammonium nitrate and carbon black tightly packaged in polyethylene. It's put in a blasthole so there are no air pockets around it, then detonated with a small primer-charge of cap-sensitive explosive. Since neither raw materials nor finished mixture are cap-sensitive explosives, they are shipped at commercial freight rates rather than at higher fixed-explosive rates.

And not only is the material cheaper, but it gives excellent fragmentation, better than most competitive products. Its effectiveness in actual mining operations is detailed in Coal Age, a McGraw-Hill publication, May 1955.

Maumee's patent covers use of Akremite in all open cast operations—stripping, mining, quarrying, etc. To give widest industry application, studies are now underway on two licensing methods: purchase of packaged Akremite from explosives manufacturers and compounding by customers.

### Oil meet features Celanese oxidation

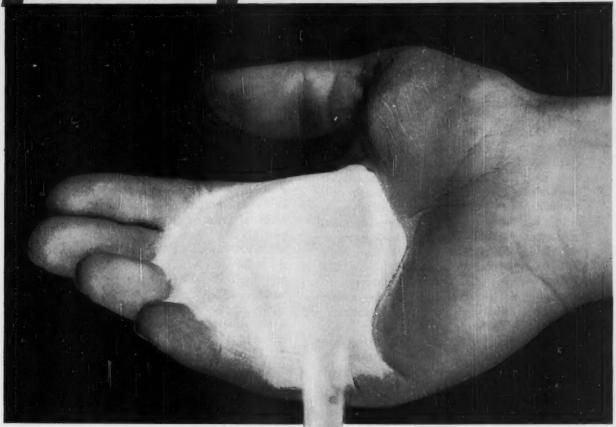
U. S. oil and chemical firms are taking keen interest in this month's (June 6-15) World Petroleum Congress in Rome, Italy. Why? They expect to benefit substantially from new information and data contained in the raft of technical papers being presented, particularly those on oil and petrochemical processes.

One of the meeting's many highlights will probably come from E. T. Powers, director of development at Celanese. In discussing "Chemicals by Direct Oxidation of Hydrocarbons," Mr. Powers is expected to reveal some hitherto unpublished details on his company's oxidation plants at Pampa and Bishop, Tex.

Text of the paper won't be released until June 8, but it is known that he'll compare two Celanese oxidation techniques—shotgun and rifle.

(Continued on page 110)

# phosphates?



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Basic Chemicals

for American Industry

At Bishop, noncatalytic vapor phase oxidation yields a lot of different compounds, hence the name shotgun. A mixture of butane and air is heated and reacted. Products are then condensed and scrubbed out with water. Over 90% of current output at Bishop consists of these purified products: methanol, propanol, isobutanol, butanol, formaldehyde, acetaldehyde, acetone, MEK, mixtures of C4-C7 ketones, a mixture of C5-C7 alcohols, oxides of ethylene, propylene and butylene.

At Pampa, on the other hand, Celanese uses liquid phase oxidation of butane in a solvent to get predominantly acetic acid. This type oxidation usually occurs at 300-475 F. and butane by itself can't be oxidized as a liquid because the temperature is above its critical temperature. But by using a suitable solvent, Celanese gets around this. Air is bubbled through the solution and unreacted nitrogen passing overhead carries with it proportionate amounts (determined by partial pressures) of butane, formic, acetic and propionic acids, MEK, acetone, methanol, etc. These gases are condensed and the products recovered. By altering reaction conditions, this same process yields increasing amounts of MEK instead of acetic acid.

Though liquid phase oxidation still gives many products, it's considerably more specific than vapor phase. And Powers expects selective oxidation to be emphasized in the future. But for best economic balance of saleable products Celanese is all for combining shotgun and rifle methods.

### Lots happening in synthetic fuels

A fistful of new studies and developments have come to light in the just-published Bureau of Mines report on synthethic liquid fuels research. These are some of the highlights:

• Removal of CO<sub>2</sub> from synthesis gas with hot, concentrated potassium carbonate solution was pilot-planted. "Substantial savings in steam and capital investment" are indicated.

• First tests were made on continuous one-step coal hydrogenation. Using ammonium molybdate-impregnated coal and volatile vehicle oil, conversion was nearly complete at 975 F. But product contained much heavy oil, little gasoline and hydrocarbon gas, so the reactor is being redesigned.

• Experimental oil shale retorting at 1,000–1,600 F. gave higher quality liquid product (measured by volatility and aromatic content). As temperature rises, so does gas production, much of which is C<sub>2</sub>-C<sub>4</sub> olefins.

• Work began on selective sorption and recovery of oxygen from air, using various metal chelates and other chemical-type oxygen carriers.

• Alcoholic KOH regenerated steel turnings used as Fischer-Tropsch catalyst. Also for Fischer-Tropsch, formation of borided iron catalysts is being studied. They would be made by reacting iron with organic boron compounds (diboranes).

All in all, another mighty busy and productive year for the Bureau of Mines (see also page 108).

### New competitor in dibasic acids

U. S. Industrial Chemicals is now designing a full-scale commercial unit to make Isosebacic acid, a versatile mixture of sebacic acid isomers currently available in sample amounts. Plant size and location await outcome of the present market evaluation program which has already placed samples with 125 companies.

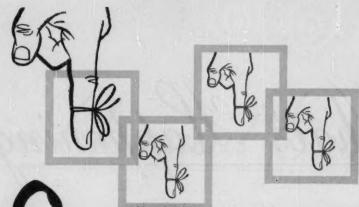
USI's process for Isosebacic is a variation of the well-known buna rubber synthesis: butadiene plus metallic sodium. Both raw materials are readily available, says USI, and both have a long history of price stability. Initial price of Isosebacic is 45¢ a lb., but it's expected to drop as demand increases.

Likely uses for the product cover a large area, ranging from plasticizers to nylon-type polyamides, from alkyd, polyester and polyurethane resins to synthesis of ester lubricants for jet planes. Evaluation of these applications, of course, is still in the very early stages.

One of the more intriguing potentials is in synthetic lubricants. In this use it would compete most directly with sebacic acid itself—now priced at 64c a lb. (Isosebacic contains 6-10% sebacic acid, 72-80% a-ethyl suberic and 12-18% a, a'-diethyl adipic.) The government would like to use sebacates for synthetic lubricants. But because sebacic acid is derived from castor oil which would be in very short supply in case of a war they've had to turn to not-so-desirable adipates. If Isosebacic can do the job it will fill a crying need.

There's some talk that USI may supply all needed raw materials for this product. The company makes sodium and speculation is that in addition to a unit to make the acid it might build a butadiene unit at Tuscola, Ill., where there is an amply butane supply. Such a move would have the added advantage of making cheaper butadiene available (because of lower shipping costs) to the now privately owned rubber plants at Louisville and Akron. As of now these plants will have to get butadiene from the Gulf Coast.

For more of WHAT'S HAPPENING.....112



Something worth remembering!

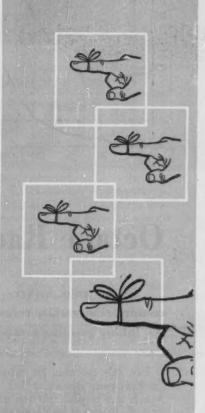
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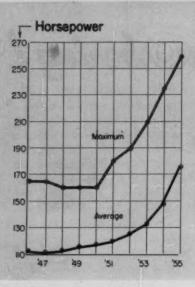
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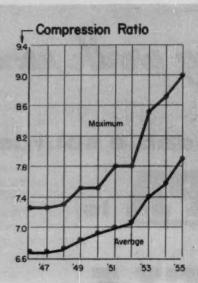
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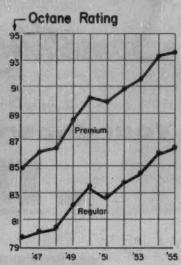


JUNE 1955

# What's Happening







### Octane Race Spawns New Processes

As auto makers boost engine horsepower and compression ratios, refiners will turn to new processes for hiking gasoline octane ratings.

Two new processes for making gasoline, both announced late in March, give promise that you may soon be filling up your tank with 100-octane motor fuel at your favorite service station.

Developers of the new processes are Universal Oil Products Co., Des Plaines, Ill., and Houdry Process Corp., Philadelphia. UOP calls its process Rexforming; Houdry's will be known as Iso-Plus reforming.

Both processes employ catalytic reforming to upgrade low-octane naphthas. They differ from conventional practice in two respects:

• Reaction conditions in the reforming step are milder.

 Low-octane paraffinic molecules resisting the first pass through the reforming process are given further reforming treatment.

The two processes differ in their embodiment of these concepts, as discussed more fully in the next two

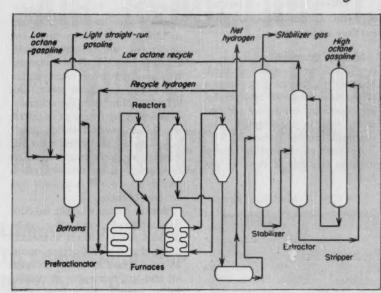
► Why 100 Octane?—Availability of 100-octane motor fuel means little to the motorist using engines of current design. But automobile engines requiring high-octane gasoline are definitely on the way. And the petroleum industry must get set for the anticipated "octane derby."

During the past eight years, average octane number of regular-grade gasoline has risen from 79 to 85. Premium fuels have jumped from 85 to 93 during the same period.

Automobile designers have taken advantage of the availability of higher-quality fuels—and have in turn stimulated petroleum refiners to turn out still better fuels—by increasing the compression ratios of their engines.

This trend has gained speed in the last two years. Whereas in 1953 the makers of less than 9% of the new cars recommended that the owner use premium fuel, today pre-

# in Chemical Engineering



-

mium fuel is urged for more than half the new models.

► More Power to You—Higher compression ratios enable the auto maker to pack more horsepower into his engine.

Just a few years ago the average car engine had a 6-to-1 compression ratio and an advertised horsepower of 110. In 1955 models the average ratio is about 8 to 1, with horsepower at about 175.

A 10-to-1 engine may be on the market next year, with 12-to-1 ratios already under serious consideration. By 1960, 300-hp. engines may be the rule.

Now that 100-octane motor fuel appears economically feasible, the race is on. Regardless of engine demands or operating economy, the first refiner to market 100-octane gasoline at the corner station will score a valuable psychological triumph.

### Rexforming . . .

Combines mild Platforming with solvent extraction to upgrade paraffin content.

UOP's Rexforming process combines catalytic reforming over a platinum catalyst—the well known Platforming process—with a solvent extraction step which separates the higher-boiling nonaromatics from the reformer product. This low-octane fraction is returned to the reaction section for further catalytic treatment.

- ► Aromatics Pose Problems Production of unsaturated cyclic hydrocarbons (aromatics) is an important part of the chemistry of catalytic reforming. Aromatics are formed in two ways:
- By the dehydrogenation of saturated cyclic hydrocarbons (naphthenes).
  - By the dehydrocyclization of

THIS MONTH'S

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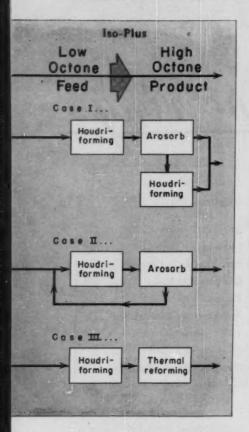
straight-chain, saturated hydrocarbons (paraffins).

Concentrations of aromatics in motor gasolines have generally been increasing along with the upward trends in octane ratings. This is because the petroleum industry is making wider use of catalytic cracking and reforming.

However, this trend has been blamed for some combustion problems. UOP's approach to the development of a process for higher octane fuels, therefore, is to minimize the aromatics content insofar as practical. This is done by improving the octane rating of the nonaromatic compounds.

Light Touch Is Answer—Paraffins undergo three reactions in catalytic reforming — isomerization, hydrocracking and dehydrocyclization. Under severe conditions you get dehydrocyclization to aromatics. But you can also get a substantial octane number increase by maximizing the hydrocracking of higher molecular weight paraffins.

In Rexforming the paraffins are partially converted under mild conditions to get the best balance of



hydrocracking and dehydrocyclization without undesirable side reactions which produce excessive quantities of gas and coke. This partial conversion of paraffins requires the continuous separation of unconverted material and recycling it to the reaction zone.

Solvent Extraction—Having had favorable experience with its Udex solvent extraction process for production of aromatics, UOP turned to liquid-liquid solvent extraction for the separation step in Rexforming.

Udex has been in operation for several years in a number of commercial installations. In combination with Platforming, it has helped the petroleum industry produce large volumes of high-purity aromatics for chemical uses.\*

Solvent used in the Udex process is a mixture of diethylene glycol and water. UOP hasn't disclosed the nature of the solvent system to be used with Rexforming. The

company points out that investment and operating costs are much lower than those for Udex, since minor amounts of aromatics can be left in the recycle stream without hurting the efficiency of the process.

### Iso-Plus . . .

# Offers three variations of mild Houdriforming plus further reforming.

Houdry Process Corp. bases its new process on its established fixedbed catalytic reforming step known as Houdriforming. As in Rexforming, operating conditions are less severe than in once-through, conventional catalytic reforming.

As shown at left, Iso-Plus reforming may take any of these various forms:

 Case I-Moderate Houdriforming of the low-octane naphtha feed, separation of the aromatics, and separate Houdriforming of the paraffinic concentrate. Separate reforming permits use of optimum operating conditions in both reforming steps.\*

 Case II—This is also a combination of Houdriforming and aromatics separation, but here the paraffinic concentrate is combined with the naphtha feed, similar to Rexforming.

 Case III—Here we have a combination of Houdriforming with thermal reforming of the product from the catalytic step. Thermal reforming upgrades the paraffins with minimum loss of aromatics.

► Separation by Adsorption — In view of Houdry's ties with Sun Oil Co., it is no surprise that Iso-Plus makes use of Sun's Arosorb process for separating the nonaromatics.

Arosorb uses selective adsorption from the liquid phase, with silica gel as the adsorbent (see Chem. Eng., Sept. 1951, pp. 234-5). However, Houdry points out that any other means of selectively separating the aromatics from the non-aromatics may be used.

The selectivity of Arosorb can be judged from these figures for a Case I example: The aromatic concentrate contains 91% aromatics, the paraffin concentrate contains 81% paraffins.

► Which Is Best?—In a study of costs and yields, Houdry engineers came up with the conclusion that Cases I and III were more attractive than Case II. Case III, Houdriforming plus thermal reforming, showed up well because of its low investment and operating costs. Case I, involving two separate Houdriformers, while having higher investment, produced more 100-octane gasoline than the others.

Whether by design or accident, the Houdry study definitely didn't favor Case II, the system most like Rexforming. Refinery engineers who set out to evaluate which process to use will have their task cut out for them.

But no matter whether Iso-Plus, Rexforming, or some other yet-tobe announced process eventually dominates the 100-octane scene, we can all look forward with interest and anticipation to an exciting octane race.

### Big Food Emulsifier Plant Goes on Stream

The second of two new Atlas Powder Co. food emulsifier plants is now running. Located at Memphis, Tenn. (the first is at Brantford, Ont.), it cost over \$1 million (Chem. Eng., April 1954, p. 106).

Two main types of products are being made: monoglycerides made by reactions of fats and oils or fatty acids with glycerine; and Span types which use sorbitol rather than glycerine as the base polyol. Besides uses in foods, the Spans are also used in cosmetics, surface coatings, pharmaceuticals and other products.

Atlas has also developed some new high-monoglyceride-content food emulsifiers that include optimum amounts of diglycerides for best dispersion and performance. Less of these high-mono products are needed to give the same results as standard emulsifiers with lower percentages of monoglycerides.

<sup>\*</sup> UOP considered separate treatment of the paraffinic concentrate in Rexforming, decided that recycling was completely practical and offered certain other advantages.

<sup>\*</sup> See pictured flowsheet, Chem. Eng., May 1952, pp. 242-5.

# LUMMUS

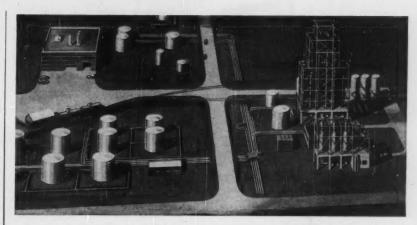
DESIGNING ENGINEERS AND CONSTRUCTORS FOR THE PETROLEUM AND CHEMICAL INDUSTRIES

# AIR REDUCTION CHEMICAL'S VINYL ACETATE PLANT AT CALVERT CITY, KENTUCKY

### Lummus-Built Plant To Come On Stream In Early 1956

The 30,000,000 lb. per year vinyl acetate plant which The Lummus Company is engineering and constructing for Air Reduction Chemical Company, a division of Air Reduction Company, Inc., is a good example of how industry can set up an integrated plant in a strategic location, and insure maximum returns for its capital investment. The plant's attractive location at Calvert City, Kentucky has all the benefits of readily available power, natural gas, water transportation, and a host of related chemical products.

This \$3,000,000 installation scheduled for completion early in 1956, is adjacent to the calcium carbide and acetylene plant of Air Reduction's National Carbide Division, and will receive pipeline acetylene from it. The new vinyl acetate plant will be a key develop-



ment in Air Reduction's chemical expansion which begins with basic raw materials and ends with a variety of products having important commercial and industrial uses.

Vinyl acetate goes principally into polyvinyl acetate emulsions, used in adhesives, latex paints and textile finishes, and polyvinyl alcohol used for adhesives and textile finishes.

Reduction's National Carbide
Division, and will receive pipeline
acetylene from it. The new vinyl
acetate plant will be a key develop
At Calvert City, in addition to
this new Air Reduction plant,
Lummus is also building a
acetate plant will be a key develop
\$6,000,000\$ high pressure acety
Plant: East Chicago, Indiana.

lene derivatives plant for General Aniline & Film Corporation. What better example could be given to show that Lummus is ready, willing and able to design, engineer and construct your next chemical plant.

The Lummus Company, 385 Madison Avenue, New York 17, N. Y. Engineering & Sales Offices: New York, Houston, Montreal, London, Paris, The Hague, Bombay. Sales Offices: Chicago, Caracas. Heat Exchanger Plant: Honesdale, Pa. Fabricated Piping Plant: East Chicago, Indiana.

### **Fermentation Opens New Chemical Doors**

Molasses & nutrients Inoculum Mixing Fermentor Holding tank Rotary filter Evoporator Crystallizer Centrifuge Crude crystals Carbon Mixing tank

Using cheap molasses, Pfizer capitalizes on fermentation know-how, gets volume output of itaconic acid. On the way: Many more such versatile chemicals.

Already well launched is a vigorous program by Chas. Pfizer & Co. of Brooklyn that's going to result not only in a new series of commercially available, fermentation-derived industrial chemicals in coming months, but also in increased stature for fermentation as a chemical production tool.

In just two months Pfizer's added five new products to its regular sales line—itaconic acid, dimethyl and dibutyl itaconates and two more esters of citric acid. All rely on fermentation for volume production.

Chemical uses for itaconic are legion (see next page), for it contains two carboxyl groups, a conjugated double bond and an allylic methylene group. The two new itaconates are similar to methacrylates and are expected to be used mostly in copolymerizations. The citric esters are both plasticizers: acetyl tri-2-ethyl hexyl citrate, the fifth in a series, and odorless acetyl tributyl citrate which has been approved by the Food & Drug Administration for use in films for food wrappings.

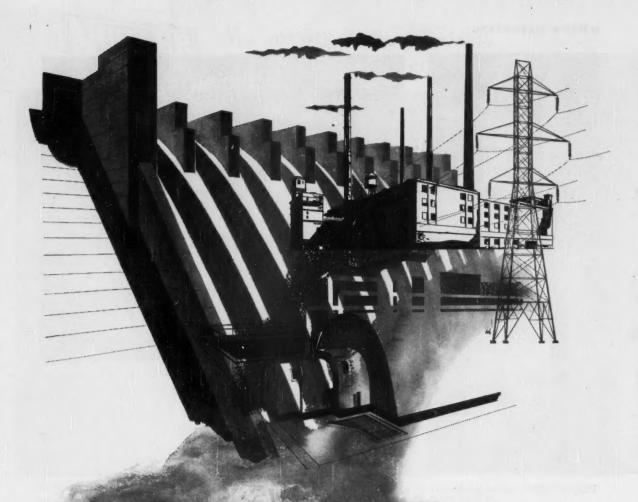
▶ One Base for All—More important, however, than any individual product is the method by which they are all produced—fermentation. And typical of much of Pfizer's fermentation is its submerged process for making itaconic acid (see flowsheet).

Itaconic is hardly a new chemical, but it's just in the past year that Pfizer's found a way to make it economically. Key to this success is use of cheap molasses as the raw material instead of more expensive sugar. (Pfizer says it can use any of three types of molasses—high-test cane, beet or blackstrap—but won't reveal which it actually does use.)

With two important exceptions the process looks much like one pilot-planted about three years ago by the Dept. of Agriculture's National Regional Research Laboratory at Peoria, Ill. NRRL used corn sugar and had 6% glucose in the charge solution. Pfizer states that its sugar concentration is "substantially higher," which gives higher yields.

Ferment, Recover—Pfizer mixes molasses with nutrients, such as nitrogen-containing salts, for the mold. This mixture and the mold (Aspergillus terreus in an aqueous medium similar to the final fermentation medium) are then charged to stainless steel fermentors. With the batch mechanically agitated, sterile air is blown in near the bottom through perforated pipes. Temperature is about 95 F., pressure is slightly positive.

When optimum itaconic concentration is reached in the fermentor (determined by titration), the broth is filtered in a precoat



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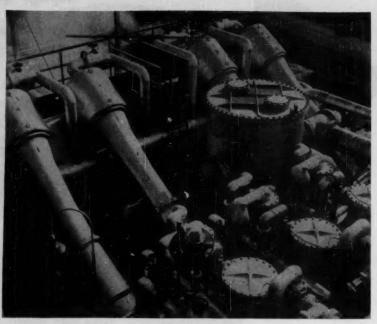
FERMENTORS: welded stainless steel.

rotary vacuum filter and concentrated in a stainless steel, multiple-effect evaporator. Crude crystals are then recovered by chilling the solution with cold water and centrifuging in a 40-in.-dia. automatic suspended batch centrifugal (Type 316 stainless steel).

Final purification follows. Water, steam, carbon (for decolorizing) and crude crystals are mixed and go to a 30-in., Type 316 stainless steel plate-and-frame filter press. The itaconic is then recrystallized, centrifuged and dried to give a white, crystalline powder.

► Commercial Stimulus—Because this process is for big-volume production, Pfizer is ready to really push the product.

In past years there's been considerable interest in itaconic as a chemical building block (over 60 use patents issued since 1940), but potential customers have pretty much felt they couldn't undertake



VACUUM WATER CHILLERS, by Croll-Reynolds, are used with crystallizers.

major evaluations because supply just wasn't reliable. Now that obstacle is gone. Essentially unlimited quantities can be had at 60¢ a lb., and price will undoubtedly drop as demand rises.

► Where It Might Go—A whole raft of possible applications have been and are being investigated, both by Pfizer and by firms like General Electric, Du Pont, Esso and Union Carbide. These uses include resins and plastics, synthetic fibers, elastomers, plasticizers and lube oil additives.

In the plastics field, itaconic can be used to make high molecular weight thermoplastics by polycondensation reactions. These can then be copolymerized with styrene or other vinyl monomers to improve the physical properties of the resulting thermosetting resins. Varying the composition of the polycondensation product will give a large variety of useful structural materials.

The acid can also be used instead of fumaric acid or maleic anhydride to make alkyd coating resins. And itaconic's diesters (like dimethyl and dibutyl already on the market) can be self-polymerized with peroxide catalysts or copolymerized with vinyl monomers to give transparent plastics.

Copolymerizing itaconic or some of its derivatives with vinyl monomers, such as vinyl chloride or acrylonitrile, gives fibers that are easier to dye. And rubber-like materials can be made by polymerizing with butadiene.

Various oil companies hold patents on the copolymerization of itaconic or derivatives with such substances as maleic anhydride and methacrylates to produce pourpoint depressants and viscosity index improvers for lubricating oils.

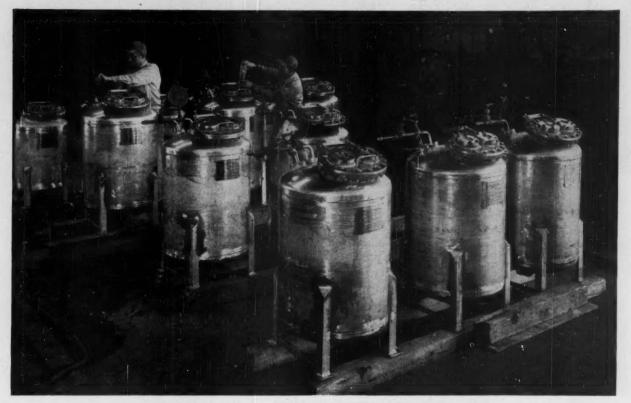
Diesters of itaconic formed from high molecular weight alcohols are suitable for plasticizing vinyl chloride resins. And some liquid polymers made from lower itaconic esters are useful plasticizers for polyvinyl chloride.

Rounding out today's picture of itaconic are applications varying from soil conditioners to cross-linking agents, from ion exchange resins to potting resins.

None of itaconic's uses has been proven commercially yet. But with ample supply available at a stable price, Pfizer is convinced that many of them will hit the big time soon.



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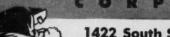
In recording-breaking time, 104 of the all stainless steel vessels, polished to a

No. 4 finish inside, and built to exacting specifications, had been delivered on time for the production of the now-famous Salk polio vaccine.

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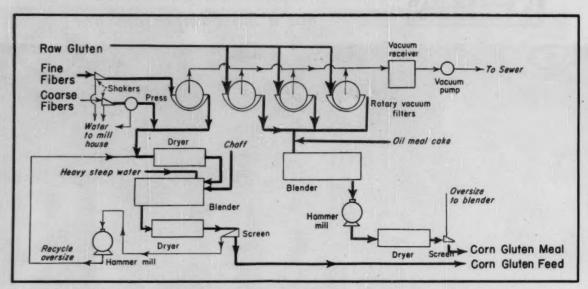
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SULFUR DIOXIDE, used to thwart fermentation in this process, poses design and operating problems. Here's . . .

### **How National Starch Licks Corrosion**

Since every corrosion problem is unique, National's engineers test materials right on the job. It paid off when they built their new byproducts plant.

Extensive use of corrosion-resistant materials for both process equipment and the surrounding areas has paid off in lower maintenance costs and higher products purity at National Starch Products' new starch bypreducts plant in Indianapolis, Ind.

Direct maintenance labor is now only about a quarter of what it was in the old plant, and replacement of corroded equipment has been almost nil in the new plant's first 18 months of operation. In addition, Don George, production manager, says: "We now turn out a purer product, have a safer plant and a steadier production flow. We've cut downtime to the bone—inspection, not correction, now takes the bulk of our effort."

Experience gained with the widespread use of corrosion-resistant materials will be further put to use—and added to—in a just-started \$3½-million companywide expansion program. Included in the

program will be further expansion and modernization of the starch plant at Indianapolis, as well as construction of a vinyl resin plant at Meredosia, Ill., addition of new adhesive-making equipment in the company's plants in Plainfield, N. J., Chicago and San Francisco and a doubling of research facilities.

► SO₂ the Culprit—The byproducts plant produces two major products—corn gluten meal and corn gluten feed—both used in high protein animal feeds. With its new equipment, National says that the products are pure enough to meet the standards for human foods.

A major processing problem is thwarting fermentation of starch solutions. Blowing sulfur dioxide into the process liquors in the starch process does this. But it also results in a weak solution of sulfurous acid in the process stream and a good deal of SO<sub>2</sub> in the plant atmosphere.

► Experience Keys Control — To control these corrosives in its new plant National picked those materials which long experence had shown were least affected.

About 15 yr. ago the company started replacing the traditional cast iron and steel-industry standbys for decades-with more resistant metals. As new materials were developed and became available, National tried them in the plant. Operators and management kept scrupulous operating records of their performance in actual service.

When the company decided to replace the old byproducts plant, it drew on this experience to engineer corrosion control into the new plant.

Making Meal—The byproduct operation's major products—corn gluten meal and corn gluten feed—are produced in similar processes. To make its meal, National takes raw gluten from the millhouse where it's been separated from the starch and thickened in stainless steel centrifugals.

In the new plant, string-discharge, rotary drum filters remove water from the solid gluten. Strings and filter cloth are nylon while the



A pencil pokes through this corroded metal! Why chance trouble like this? Cathodic Protection and Anaconda Type CP Cable effectively check corrosion of buried metals.

# CHECK CORROSION by cathodic protection with Anaconda Type CP Cable

Corrosion of buried metals costs industry over a billion dollars a year!

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Corrosion—caused by minute electric currents flowing from metal into adjacent soil—is checked by applying direct current from an external source. This eliminates anodic areas, makes the entire metal surface cathodic and stops the flow of current from the metal.

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corrosion?...and detailed information on Anaconda Type CP Cable? Ask the Man from Anaconda — or send for bulletin DM 5450, "Anaconda Cathodic Protection Cable." Anaconda Wire & Cable Company, 25 Broadway, New York 4, N. Y.

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COPPER AND ALUMINUM WIRE AND CABLE

Where Anaconda Type CP Cable and Cathodic Protection Cut Corrosion Costs.

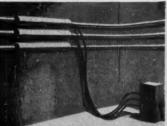
Lead-covered cable

Underground storage tanks

Transmission towers



Gas mains and water pipes







rest of the filter is Type 316 stainless. An all-stainless blender mixes oil meal cake and some dried meal with the gluten and a mill grinds the mix. A 8-ft. diam. by 35-ft. long steam-tube rotary dryer cuts the moisture content to less than 10% by weight, and dried meal is screened and blown to storage.

Since the corrosion problem ends after drying, dryer and screens are of mild steel and ducts through which the material passes are made

of galvanized sheet.

▶ Fibers to Feed—To make the corn gluten feed, National uses the fibrous part of the corn kernel. Several water washes at 115 F. remove traces of starch from the fibers. A 316 stainless pulp press squeezes water from the coarse fibers while a filter of the same type used for the gluten recovers the fine fibers. Currently, fibers are mixed and dried in a steel steamtube dryer.

Protein-containing heavy steep water from an earlier milling operation blends with the fibers and, after a second drying, the blend is screened and sent to storage. Oversize is ground and recycled to the

first dryer inlet.

▶ Relies on 316—Throughout both processes National relies chiefly on Type 316 stainless steel. Actual operating experience with other types of stainless, aluminum, bronze, and with rubber linings showed these materials to be unsatisfactory under the particular operating conditions of these processes.

For example: National moves the fibers from the press and the filter to the first dryer in a screw conveyor made of 316 stainless operating with babbitted bearings and bronze hangers. After 18 mo. the original equipment shows signs of wear but no evidence of corrosion. In the previous plant these conveyors were usually made of carbon steel—and none lasted over two months.

In going from carbon steel to 316 National tested many types of materials — including aluminum, 304 and 306 stainless. Constant agitation in the conveyor caused the most trouble with these materials.

► In Area Air—SO₂ is also found in the air in the plant, and thus presents a whole new set of corrosion problems. At National, they solved these by tiling walls, ceilings and one floor; laying acid brick on other floors; covering exposed metal surfaces with a vinyl mastic and eliminating window sashes—once particularly troublesome—by putting a band of glass brick around the building on each of the three floors and using a system of forced circulation for air.

Also eliminated were the wooden floors and stairways of the previous plant. Though they stood up to the corrosive fairly well, these became quite slippery when wet and were constant fire hazards as well.

### First Fluid Coker Starts Operations

At Carter Oil's Billing's, Mont., refinery, the world's first Fluid Coking unit is on stream, performing smoothly and ready to go to full capacity as soon as enough feed stock is available. Feed rate now is 2,700 bpd., about 70% of design. But even at this low rate heavy fuel production has been completely eliminated at the refinery.

Fluid Coking was developed by Esso Research and Engineering Co. (Chem. Eng., Oct. 1953, p. 126). It uses a moving bed of coke for both heat and material transfer. Heavy residual oil is introduced into the hot coke bed where it decomposes to lighter oils and coke. Oil vapor passes from the reactor and the coke adds to the volume of the moving bed. Coke inventory is kept constant by continuously removing net coke production.

### Sinclair's Working Hard on Shale Oil

Controlled underground combustion of oil shale to yield petroleum products is being intensively studied by Sinclair Research Laboratories. Preliminary work indicates that oil can be recovered this way and now a new series of field tests is starting in Colorado to develop operating techniques, cost figures and optimum operating conditions.

The Sinclair process retorts shale in place. Oil produced is then pumped to the surface as in conventional crude oil production. The firm's oil shale deposits in Colorado represent commercial reserves of 700 million barrels.

#### Convention Calendar

Chemical Institute of Canada, 38th annual conference, Quebec City, May 30-June 1.

Canadian Pulp and Paper Association, Technical Section, Chateau Frontenac, Quebec City, June 6-9.

Committee on Vacuum Techniques, second symposium on vacuum technology, Mellon Institute, Pittsburgh, Pa., June 7-9.

Armed Forces Chemical Association, 10th annual meeting, Hotel Cleveland, Cleveland, Ohio, June 16-17.

Second annual materials handling training conference, two-week seminar directed by J. R. Bright (c/o Harvard Business School. Boston), Lake Placid, N. Y., June 19-July 2.

American Society for Engineering Education, 63rd annual meeting, Pennsylvania State University, University Park, Pa., June 20-24.

American Society for Testing Materials, 58th annual meeting, Chalfonte-Haddon Hall, Atlantic City, N. J., June 26-July 1.

American Nuclear Society, first annual meeting, Pennsylvania State University, University Park, Pa., June 27-29.

Technical Association of the Pulp and Paper Industry, conference on statistics in the paper industry, Forest Products Laboratory, Madison, Wis., July 10-23.

Western Plant Maintenance and Engineering Show, Pan Pacific Auditorium, Los Angeles, July 12-14.



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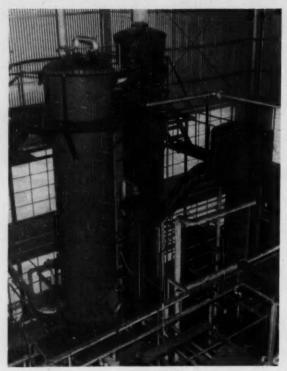


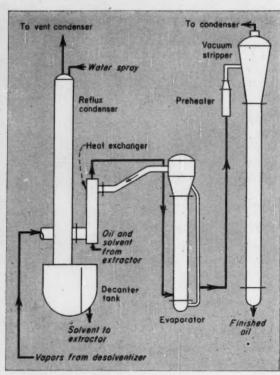
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Solvent recovery area at Southern Cotton Oil Co.'s Newport, Ark., solvent extraction plant.

### **Compact Design Cuts Extraction Plant Cost**

Simplified arrangement of equipment and piping accounts for an over-all initial cost saving of 30%—compared with conventional plants of similar capacity.

Good design at low investment is the claim for Southern Cotton Oil Co.'s new solvent extraction plant at Newport, Ark.

What makes Southern's plant different is its redesigned equipment and layout. Simplified design and piping account for an overall first cost saving of 30%—compared with orthodox plants of similar capacity.

The process itself is conventional: Dehulled, delinted seeds are cooked, flaked, then extracted with hexane; solvent is recovered from the extract by evaporation and stripping; cooked meal is desolventized, toasted and ground.

From an operational standpoint, this plant-on stream since last

September—is unusual in that it can handle cottonseed and soy-beans either separately or simultaneously. It is rated at 270 tons per day of cottonseed or 250 tons per day of soybeans.

► Solvent Recovery—One of the novel features at the Newport installation is the solvent recovery area—i.e. evaporator, condenser, vacuum stripper and decanter.

An improved, compact arrangement of equipment (see cuts) has resulted in a 40-50% saving in cost over conventional vapor and condensate piping. Here's how:

Flash chamber and evaporator are combined in a single unit.

• One large reflux condenser for both evaporator and desolventizer-toaster vapors—sits atop and is an integral part of the decanter tank. A large condensing load insures good flow of solvent draining back on the inside of the condenser tubes. This flow, together with a water spray at the condenser top, keeps the tubes clean by preventing the accumulation of fines. The water spray also provides additional condensing capacity.

• Only one vent line and one cooling water line are required. While the water line is 6-in. dia. (somewhat larger than in other plants), it is still cheaper than running several 3-in. and 4-in. lines.

 The vacuum stripper condenser is mounted on a platform directly below an elevated safety water tank so that only a barometric leg is required to return condensate to the decanter tank.

► Extractor—Another new look is Southern's horizontal extractor, made by French Oil Machinery



for safe, economical delivery of your product . . .



for fast supply service from conveniently-located plants . . .



Co. This machine resembles a bucket elevator turned sideways. Prepressed cottonseed or flaked soybeans are fed into perforated baskets—on an endless belt—which travel across the top pass and return on the bottom pass. Pure hexane enters on the bottom pass.

Craig Sandahl, Southern's construction engineer, claims that this unit simplifies solvent flow and eliminates 40-50% of conventional extractor piping.

► Added Cost-Savers—Other features of which Sandahl is proud are:

 Seed cookers — Hydraulic cookers, on 13-foot legs, feed directly into expellers.

 Meats bin—Variable pitch screw and variable drive replace conventional drag-type feeders.
 The variable pitch screw permits continuous feeding and better rate control of seeds to the expellers.

• Flaking rolls—In lieu of American (solid) flaking rolls, Southern uses German (hollow) rolls. These are said to give better wearing characteristics. They last 6-8 times longer than American rolls and cost only half as much (including shipping charges and import duty).

• Controls—All process controls are brought to a central control panel. In addition, the carbon adsorption towers are automatically controlled. Thus, with the exception of the extractor, the operator can watch the complete process from the floor.

► What's Ahead—Southern feels that its aim—to reduce initial investment without sacrificing operational features—has been accomplished. Still in the works is the problem of producing a meal that will meet market acceptability.

Finished meal has a low enough oil content but is dusty—because of fine grind. Southern hopes to eliminate the objectionable dust by screening, aspiration and reagglomeration through its prepress operation (rather than by the conventional acidulated soap stock treatment). Tests on larger-than-laboratory scale are now under way. If results are successful, the technique can be incorporated in other plants with little additional expense.

### Activity Heightens In Mexican Chemicals

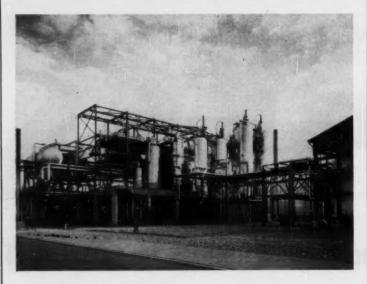
In recent months Mexico's infant chemical industry has definitely started to grow up fast. New projects are sprouting all over the country. Here's a quick rundown on the more important ones:

Mexican Gulf Sulphur Co.
 has started the first big exporting of Mexican sulfur — long-awaited, but much-feared by U. S. sulfur companies. Initial production from Mexican Gulf's mines on the Isthmus of Tehuantepec actually began last summer, but insufficient dock and loading facilities have delayed until now any major sales outside Mexico.

 Monsanto, which has been making synthetic resins and molding materials in Mexico since 1951, plans to expand its plastics output there and also to get into production of basic chemicals. No details are available. Current capital investment by Monsanto in Mexico is just under \$1 million.

• Reichhold will build its first Mexican plant soon, a \$480,000 installation that will turn out some 40 chemical products, including phthalic anhydride, formaldehyde, resins and plasticizers. Like many U. S. chemical firms that are expanding into Mexico, Reichhold gives as a major reason that needed raw materials are available there for the first time.

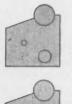
• Johnson Wax will build a new plant in Mexico to make



### Deasphalter Uses Novel Propane Removal

First of its kind to use multiple effect evaporation to remove propane from the oil stream, this huge new lube oil deasphalting-decarbonizing unit in Holland is achieving extra high heat economy. The unit, operated by Royal Dutch Shell, charges 12,000 bpd. of oil and circulates nearly 100,000 bpd. of propane.

High propane-to-oil ratio boosts extraction efficiency, but it also ups heat load. So the designers, Badger Process Div. of Stone & Webster Engineering, included two-stage evaporation. First stage is a fired heater (right) running at 175 F. Hot propane from here is the heat source for the second stage (center) which operates at 145 F.



# 24,000,000 btu/hr



# at new CHEMSTRAND NYLON plant



Two of the three 8,000,000 btu/hr, 650F, 58 psig Dowtherm vaporizers installed in Chemstrand's new nylon plant at Pensacola, Fla.

In this huge, modern plant at Pensacola, Fla., the Chemstrand Corporation is now operating the first wholly integrated nylon manufacturing unit in the United States. Here nylon yarn is produced from raw materials to finished product in a single plant.

The synthesis of hexamethylenediamene adipate from its component elements, and its subsequent polymerization, require high temperatures which must be very closely controlled throughout the various processes. These exacting thermal requirements are met by three 8,000,000 btu/hr Dowtherm vaporizers, engineered, manufactured and installed by Foster Wheeler.

Wherever industrial processes call for indirect heating with pinpoint temperature control, in the 350F to 700F range, low-pressure Dowtherm systems by FW offer many important advantages. For the complete story, send for your copy of Bulletin ID-54-5. Foster Wheeler Corporation, 165 Broadway, New York, 6, N. Y.



household, auto, industrial and agricultural waxes. About 70% of the required raw materials will be domestic. The rest will come from the U.S.

· Celanese is starting nylon production in Mexico at a rate of over a million pounds a year. A second unit with the same capacity is also contemplated. Mexico now imports about \$12 million worth of nylon fiber and fabric annually.

· Two new sulfuric acid plants are now producing in Mexico. One belongs to Alkamex, S. A., and has a capacity of 20 tons a day of 98% acid. The other is owned by Magnesio, S. A., and can make 30 tons of acid daily. Both are contact plants and both were built by Chemiebau of Nieder-Marsburg, Germany.

· Not so smooth is the prog-

ress of a proposed \$20 million, government-owned fertilizer plant on Mexico's Gulf Coast. Though the country badly needs such a plant's output (800,000 tons a year), there's a fight in the government over where the necessary capital should come from. One faction wants to bring in foreign capital via the World Bank. The other prefers private initiative and wants the government to keep out of business.

### Big Doings In Northwest Ammonia

Shell Chemical's new anhydrous ammonia storage terminal at Pasco, Wash., last link in a \$23 million distribution system designed to spread 50,000 tons of agricultural

ammonia through the Pacific Northwest, is formally open. Success of the water-route system has allowed Shell to cut the price of ammonia twice in eastern Washington and Oregon.

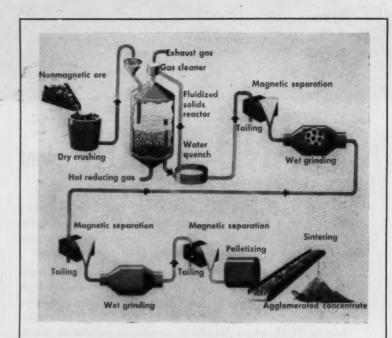
Continued growth of the area's anhydrous ammonia market, based in part on the 75,000 acres of new land opened each year in the Columbia Basin Project alone, caused Shell to build a second ammonia plant at Ventura, Calif., and develop its extensive distribution setup. Shell also plans to supply industrial ammonia by rail from its Pasco and Portland, Ore., ter-

This same rapid growth in the use of ammonia fertilizers and the development of new irrigated farm lands in the Northwest have resulted in projects by four other firms: Brea Chemicals, a Union Oil subsidiary, is completing a storage plant in East Pasco; Columbia River Chemicals plans to construct a \$12 million ammonia plant at Attalia, about 10 miles from Pasco: in Portland, Pennsalt is operating a tiny 15-ton-per-day ammonia plant: Cominco has been talking seriously about a similar project at Portland.

### Major Isocyanates Plant in the Works

By early 1956 National Aniline Div. of Allied Chemical will be producing organic isocyanates from a new plant now under construction at Moundsville, W. Va. All chemical raw materials are to come from within the Allied Chemical organization.

Included in the proposed list of products are di-isocyanates of toluene (TDI), ditolyl (TODI) and diphenylmethane (MDI), which now come from National Aniline's interim plant at Buffalo, N. Y. These products are getting a lot of attention, particularly their potential as raw materials for improved synthetic rubbers, resins, plastics, adhesives, surface coatings and fibers. Biggest interest now is in production of polyurethane foams from isocyanates.



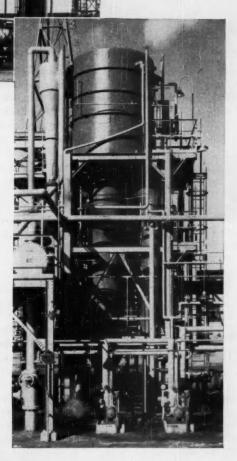
### **New Process Magnetizes Low-Grade Iron Ore**

Though still in the pilot plant, high hopes are held by Jones & Laughlin Steel Corp. for its new method of processing nonmagetic iron ore-rendering it magnetic so it can be concentrated by simple magnetic separation.

J&L employs a new type of fluidized solids reactor now used mostly for roasting sulfide ores.

Nonmagnetic taconite (30% iron) is ground to -14 mesh, then reduced to magnetite with hot reducing gas. On leaving the furnace, hot ore is water-quenched to crack it and thus facilitate fine grinding and better separation of iron from silica. Then conventional magnetic separation gives agglomerated concentrate containing up to 63% iron.

### A Reactivator tower for Monoethanolamine... or a Urea Concentrator...



... a pressure vessel or a storage tank ... Chicago Bridge & Iron Company is building them throughout industry today. CB&I is a specialist . . . with strategically located plants staffed to design, engineer, fabricate and erect welded steel plate structures to meet the most exacting requirements. Our plants are equipped for stress relieving and X-raying and have facilities for pickling and painting fabricated material.

When planning welded plate structures of any sort, be sure to write Chicago Bridge & Iron Company's nearest office. They will provide information, estimates or quotations.

Top left: 10-ft. 6-in. diam. by 87-ft. 6-in. high monoethanolamine (MEA) reactivator, fabricated by CB&I for the Grand River Chemical Division of Deere and Company at Pryor, Oklahoma.

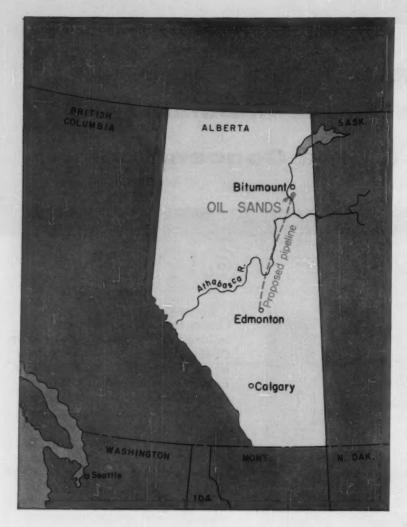
Lower left: Conkey single effect evaporator of the vertical tubular type, all stainless steel construction, for production of high concentration urea liquors for subsequent "Prilling".



# Chicago Bridge & Iron Company

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### Will We Mine Oil?

Recovery of oil from known tar sands would supply our needs for 2,000 years. New Can-Amera centrifugal separation process may key the unlocking.

As the summer thaw sets in along the Athabasca River in Alberta, Can-Amera Oil Sands Development, Ltd., is beginning large-scale tests of a new separation process for recovering crude oil from tar sands. If recently announced pilot-plant results (see Chem. Eng., Nov. 1954, p. 106 and Feb. 1955, p. 104) can be translated into commercial production, a new oil boom is in the offing.

The results of this Athabasca test could have world-shaking impact. Geologists estimate that there are over 700 billion barrels of oil locked in six major oil sands deposits scattered throughout the world. That is almost 15 times the world's known liquid petroleum reserves and represents a 2,000-year supply at current rates of consumption—if and when separated from accompanying sand.

Roughly half of this reserve lies in the United States and Canada. The largest field (1,800 sq. mi., up to 165 ft. deep) is located along the Athabasca River north of Edmonton. Other deposits occur in at least 20 states within the U.S.

These oil-soaked sands vary in bulk density. Some deposits in Alberta, Utah and California are actually free-flowing sands. Others, such as the so-called rock asphalt deposits in Kentucky and Utah, are actually sandstones that must be fed through a jaw crusher before further processing. And none of them are to be confused with oil shale which is a completely different raw material (see explanation on p. 132).

The Sunnyside deposits in Utah have been worked commercially for a number of years. Some 200 tons/day of rock asphalt are mined during the summer months for road building. Potentially these deposits alone could supply 410 million barrels of bitumen in known reserves and an additional 320 million barrels of "inferred" reserves.

During the past quarter century the U. S. and Canadian Governments—as well as various independent researchers—have spent several million dollars trying to unlock the secret of the sands. From their work a number of processes have evolved including flotation methods, hot and cold water extraction, and a variety of solvents. Although there was some interest a few years ago in the Chemoil process that uses only water and the oil sands themselves, no process has proved economically feasible.

► New Solution—Now, however, Can-Amera thinks it has licked the problem. According to President S. M. Paulson, here's how:

 After strip mining, oil sands are diluted with a light oil to raise the gravity and make it flow.

• Then the mixture is fed to a centrifugal separating machine. There is a constant layer of water and an undisclosed chemical. The oil sand and diluent are thrown through the body of water with a centrifugal force. This causes the oil, sands and clays to separate by differences in densities.



EARING SITUATION

What used to be done by hand is now done automatically.

We're referring to your specification of a Trabon lubrication system, which absolutely guarantees that the right amount of oil or grease will be delivered to vital bearings, at the right time and in the right place.

Our patented progressive feeder system assures this measuring-cup accuracy because the operation of each feeder depends on the previous feeder having op-

#### TRABON REVERSIBLE SYSTEM

This system is simply a lubricating pump and a series of reversing feeders, connected with a single line of pipe or tubing, forming a continuous sealed circuit running from the pump, around the machine and back to the pump. As the lubricant oil or grease travels, it operates the metering piston of the first feeder in the line, which discharges an exact volume of lubricant to the bearing connected to that outlet. The operation of this piston exposes a port in the feeder, thus permitting the lubricant to flow on through the circuit to the next feeder in line, where the operation is repeated. When the last feeder has discharged its lubricant, the main flow travels back to the pump where it operates an indicator stem, thereby giving visible proof that the circuit has been completed.

### TRABON MANIFOLD SYSTEM

The Trabon Manifold Systems are single line combinations of feeders or measuring valves, with no external moving parts and no soft packings, which accurately proportion the volume of lubricant discharged by a pump (either manually or automatically) to the bearings of a machine. The feeder sections are manifolded into distributor assemblies to serve groups of bearings. One assembly, the first one from the pump, often serves as a master block, feeding secondary assemblies, which in turn discharge the correct volume to each connected bearing. The "M" and "MX" feeders are the same type, the "MX" being the larger.

Get your bearings on a Trabon system.

Trabon Automatic Lubrication Fits Any Bearing Situation

Bulletin 529 will give you more details.

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**BASIC SYSTEMS:** 

• Each one then flows from the machine separately.

► The Machine—The portable extraction unit was designed by Gordon R. Coulson, Can-Amera's chief engineer, and built by the DeLaval Separator Co., Poughkeepsie, N. Y.

Coulson developed the machine in his Calgary workshop over a period of years. Last year 25 tons of tar sands and a set of design drawings were shipped to Pough-keepsie for construction and tests of a pilot model. An air of secrecy surrounds the actual design but here are the details that have been released since the completion of the preliminary tests:

• The separator is a completely portable field unit.

• It removes sand, fine clays and water giving a claimed oil recovery of 98%. This is much higher than by any previous method because the "fine stuff" is removed by the separating machine.

• The recovered oil is free of emulsion, sediment and water.

 The unit is now operating as a pilot plant at the Bitumount, Alberta, site, where tests will continue throughout this summer.

• Necessary data have already been collected for designing full-scale equipment. Can-Amera officials say that eventually full-size operating plants would be set up for operation in banks 20 units. One man would operate each bank. Each bank, covering a space of 10 by 35 ft., would have a capacity of 500 barrels of oil (net recovery) per day.

Separating machines are electrically driven and would be operated by the company's own power from waste products that are burned.

▶ How Good Is the Oil?—The high quality of this long-locked oil is being stressed. Can-Amera officials state that the oil that would enter a projected pipeline at Edmonton would be a semirefined oil in excess of 25 API gravity, capable of being broken down into premium gasoline and jet and diesel fuels.

A coking plant would be built at Bitumount. Coking will give a 20% loss of oil, but the end product that would go to Edmonton is

### **A Matter of Definition**

OIL SHALE can be defined broadly as a variety of compact sedimentary rock, generally laminated, that contains little or no oil but does contain organic material, derived from aquatic organisms or waxy spores and pollen grains, which is convertible to oil by heat. A precise definition for oil shale has not been formulated and universally agreed upon owing to the wide range of composition and properties of this type of rock.

Oil shales should not be confused with rocks that are naturally impregnated with oil, for example . . .

OIL SANDS (also known as tar sands and bituminous sands) are sands that are impregnated with a heavy petroleum. Oil sands or similar deposits are found in most areas of the world where petroleum is found. Although the sand is unconsolidated, the content of viscous oil at low temperatures holds it together tenaciously.

Source — Kirk-Othmer Encyclopedia of Chemical Technology.

described by Coulson as "600degree end point gas oil, sulfur free, that will have a higher value than any oil in Alberta in terms of products that can be made from it in modern refineries. One barrel will produce 27 gal. of premium gasoline."

In regard to sulfur content, it was disclosed that Can-Amera has some 30% less sulfur in its product than has previously been found in oil-sands experiments. In the Can-Amera process the sulfur seems to concentrate in the waste product rather than the oil.

Analyses made by the Foster Wheeler Corp., Carteret, N. J., showed a surfur content of 3.15% in the coker distillate that would go into the projected pipeline from Bitumount to Edmonton. CanAmera plans to build a sulfur-recovery plant at Edmonton.

► What Will It Cost?—Can-Amera now estimates the cost of mining the oil sand at 26.4¢ per cu. yd.\* By excavating a hole 20-ft. wide, 100-ft. deep and 1-mile long, yearly oil production would be in excess of 6.000.000 barrels.

The Alberta Government estimates that Athabasca oil would bring at least \$3.50 per barrel at the Great Lakes Terminal of the Canadian pipeline, estimated production costs were \$3.10.

However, Can-Amera officials claim that their separating technique is so superior to any other tried in the past that development of the sands can be carried out for less than 35% of previous cost estimates, or about \$1/bbl., leaving an adequate margin for pumping costs and profit.

In addition some rare minerals in the sands would justify recovery, it is believed. Also, Athabasca sand from which the oil is removed is 97.2% pure silica. This promises excellent commercial possibilities for glass production.

▶ What Now?—Can-Amera has an 18-month lease on the Alberta Government's experimental recovery plant in Bitumount with an option to lease 5,874 acres of the oilbearing sand along the Athabasca River.

If tests this summer bear out all the claims, Can-Amera will go ahead with plans to raise between 35 and 50 million dollars for full-scale development. This will include mining equipment, separating equipment, a coking plant at Bitumount and a 300-mile, 103-in. pipeline to Edmonton. (Some critics question whether Alberta sands can support heavy machinery during the summer thaw.)

▶ Other Companies—Many other companies hold leases in this same area. Among them: New Continental Oil Co. of Canada, Socony-Vacuum Exploration Co., Sun Oil Co. and Shell Comar, Ltd.

We queried some of their spokesmen. Their comments varied, ranging from extreme interest to waitand-see. One was more forceful. His summary of the whole announcement: "eye-wash."

<sup>\*</sup> In 1950 the Blair Report to the Alberta Research Council estimated the cost at 55¢ per cu. yd.

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HIGH VOLTAGE POWER CABLE INSULATION



LONG-WEARING AGE-RESISTANT TRACTOR TIRES



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To find out how Enjay Butyl can improve your product, contact the Enjay Company. Our technical representatives and laboratories are at your service.

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### Shea Will Double Phosphorus Capacity

Beginning this summer, Shea Chemical Corp. will spend \$5 million to double its capacity for elemental phosphorus and sodium phosphate. Four projects are involved: a second 20,000 ton phosphorus furnace at Columbia, Tenn.; a new phosphate-rock washing and preparation plant also at Columbia; a new sodium phosphate and phosphoric acid plant at Dallas, Tex.; and enlarging the phosphoric acid, dicalcium phosphate plant at Adams, Mass., to allow production of a number of organic phosphorus compounds.

Top billing, of course, goes to the two Tennessee plants. The rock preparation unit will give Shea an integrated operation—from the mines to finished chemicals. And the big new furnace will permit continuous production and make possible greater efficiency in effecting periodic shut-downs in the event of power curtailments for routine maintenance and repairs.

Power for the new furnace — 33,000 kwh.—will come from TVA, the present supplier, when operations begin in the fall of 1956.

### Big New Catalyst Unit Planned for Maryland

. W. R. Grace's Davison Chemical Co. plans to build a new \$4 million plant at Curtis Bay, Md., to make microspheroidal petroleum cracking catalysts. It will replace an existing plant that produces powdered catalyst.

Of key importance in Davison's process are 50-ft. high, cone-shaped spray dryers. Liquid catalyst sprayed into these forms into droplets

which are solidified by heat. Catalyst raw materials are sulfuric acid, ammonia, sodium silicate and aluminum hydrate.

### Major Expansion Set For Vinyl Chlorides

At Springfield, Mass., Monsanto Chemical Co. is expanding its plant for vinyl chloride polymers and copolymers, expects to double its share of the present U. S. production of these resins (400 million lb. a year). First production is scheduled for early 1956.

Monsanto's position in the field has grown rapidly in the past few years. Says vice president Robert K. Mueller: "Specific recent Monsanto developments include resins for flooring, phonograph records, wire and cable insulation and paste resin applications. Production capacity is being boosted to help meet immediate and anticipated requirements of these industries."

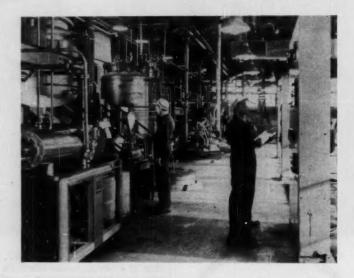
#### News Briefs.

Sodium Chlorate: Oldbury Electro-Chemical Co. has already started expanding its Columbus, Miss., sodium chlorate plant that went on stream only last October.

Glass: International Minerals and Chemical Corp. is building a \$1.5 million unit at Blue Mountain, Ont., to process nepheline syenite, a high-alumina, highalkali mineral important as a raw material for glass and ceramics.

Chlorine: Frontier Chemical Co., Wichita, Kan., plans to double its chlorine-caustic capacity and to build a new chlorinated solvents plant. Total investment will be \$6 million.

Petroleum: General Petroleum's new \$40 million, 35,000 bpd. refinery at Ferndale, Wash., the first major refinery in the Pacific Northwest, is on stream. During the next two years \$5.6 million will be spent to enlarge it.



### Go Semicommercial for Smoother Development

To further evaluate the many new products that pass all pilot plant tests but still aren't ready to go commercial, American Cyanamid has just put in highly complete, versatile semiworks facilities at Warners and Bound Brook, N. J. Designed to produce a wide variety of chemicals by several different

processes, the units' purpose is to minimize management's risk when building commercial plants.

At Warners (above), stainless steel and glass-lined equipment will be used for general manufacturing. Hydrogenation and other highpressure work will be done at Bound Brook. tor taster Drying -cleaner -dustless -no crystal

- breakage

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Faster, uniform heat transfer, plus rapid vapor removal, means today's best in vacuum drying with the Patterson CONAFORM. You get the extra values of gentle product handling, exceptional ease of cleaning into the bargain. Write for our new CONAFORM DRYER BULLETIN detailed, free!

Richard J. Carrowy





#### VACUUM TIGHT DUSTLESS DISCHARGE VALVE

Specially-designed discharge valve is vacuum-tight, dustless, full opening, easy to operate. Unobstructed flow speeds emptying—no grooves to trap materials—sleeve attachment permitted.

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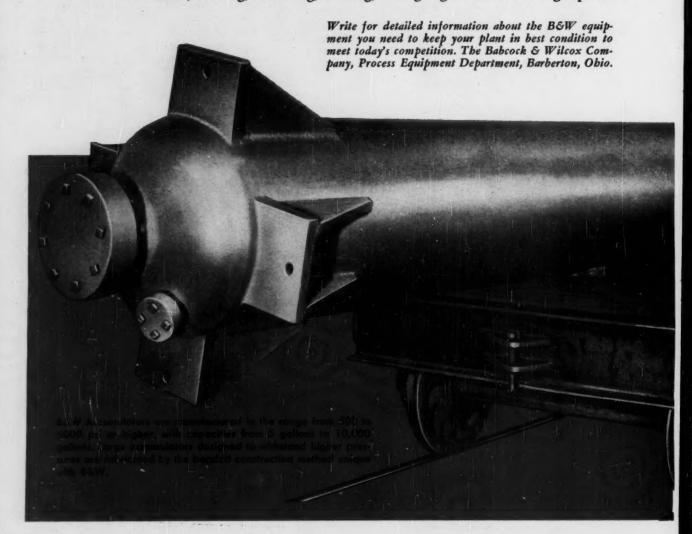
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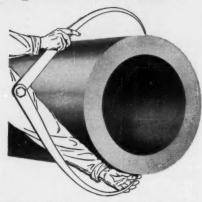
At B&W, forming, machining, welding,

X-raying and stress relieving are all performed on equipment specially designed for the job, much of it developed by B&W. And for temperature and pressure problems that arise, new and practical solutions are continually being developed through designing skill based on long experience.

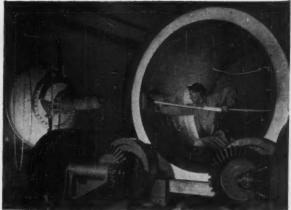


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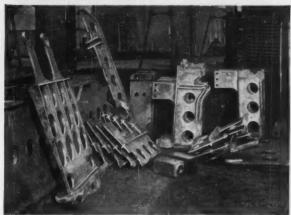
# requirements



B&W Hollow Forgings are large-diameter, heavy-wall pipes or tubes that offer the designer the advantages of single lengths or many lengths, "tailor-made" to his requirements . . . prompt delivery even on small orders . . . full forging properties resulting from thorough working of the metal . . . excellent concentricity . . . a wide size range. They are supplied in a wide range of carbon and alloy steels, produced in accordance with ASTM Specifications A106, A266, and A335.



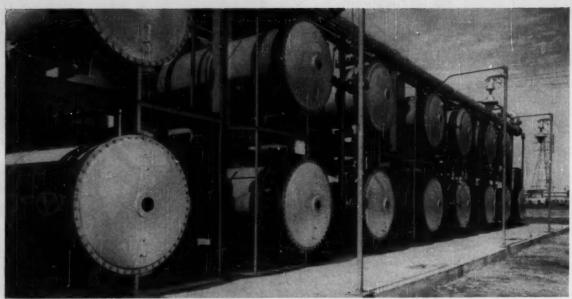
2,000,000-volt X-ray is the all-seeing eye that checks the soundness of welds.



B&W Alloy Castings are cast-to-last . . . designed for long life under the most rigid service conditions requiring superior resistance to abrasion, high pressures and high temperatures.



### Chemicals and Raw Materials Edited by D. R. Cannon



OZONATOR BATTERY serves Emery's oleic oxidation plant-scene of a pioneering chemical effort with tonnage ozone.

### Have You an Oxidation Job for Ozone?

Despite a pretty stiff investment cost for ozone generators, it may pay you to give this powerful, yet selective, oxidant a crack at your processing problems.

Let's start off on solid footing by admitting that ozone still is not a low cost chemical. A sizable capital investment in generating equipment must be reckoned with in adding up ozone's total cost to you.\* (See pp. 314-316 for details.)

But, at the same time, we can safely say that ozone's operating costs are a good deal lower—even if we throw in an allowance for depreciation—than some engineers think.†

Furthermore, ozone's unusual chemical makeup more than balances, in many instances, all these cost factors. For ozone provides the chemical processor with a combination of properties that is unique among oxidants:

Selective, specific oxidation
 -ozone gives higher yields of the right products.

• Oxidation at moderate temperatures and pressures—a boon to processors of sensitive materials and a potential savings in fuel and power for everyone.

 High oxidation potential ozone reacts rapidly and nearly quantitatively.

† Under favorable conditions—high capacity, 360-day-a-yr.-operation, a tonnage supply of byproduct oxygen, low costs for power, steam and water—and depreciating on a ten-year basis ozone will cost between 5 and 10¢ per lb. In fact, on an equivalent oxidizing power basis and disregarding an allowance for return on investment, ozone will give any oxidant, save, perhaps, air and oxygen, a good run.

· High purity.

 On-the-spot generation as used—ozone use involves no storage or handling of chemicals and lends itself to continuous, automatic and closely-controlled operations.

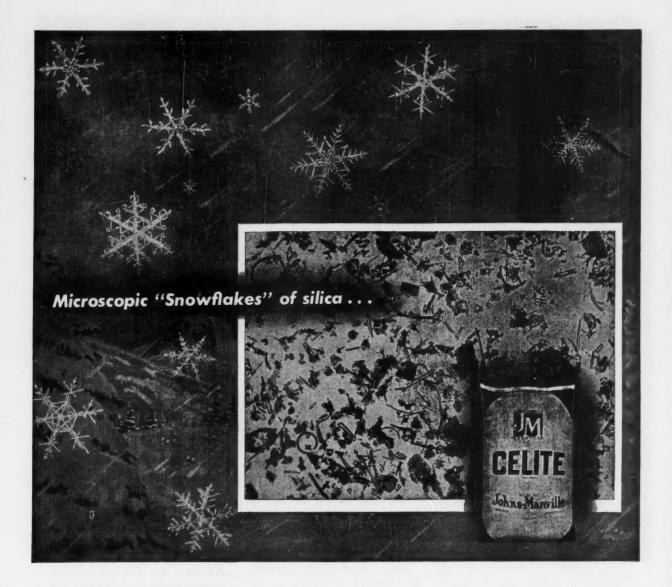
There's More Below—Like an iceberg hiding its bulk beneath the water's surface, there's far more to ozone's industrial stature than meets the eye or the ear. Little has been published. In fact, little of the over-all picture is known even to chemical processors using ozone in lab and plant. Two known facts, however, point to plenty of interest:

• Of the top 20 chemical companies in the U.S., 17 are using ozone generators of various sizes.

• Several U.S. companies are already in commercial production and use of ozone: Emery Industries, Merck, Upjohn, Schering and others.

Welsbach Corp., Philadelphia, Pa., as the first and foremost manufacturer of ozone generating equipment, is in a position to know the

<sup>•</sup> Even for large ozone units of oneton dally capacity operating on the most economical raw material, byproduct oxygen, capital investment will run \$100 per pound of dally ozone capacity. Small units—less than 500 lb. ozone per day—running on air will cost \$300 and more per pound of daily ozone capacity.



### Celite's diatomite structure steps up performance in paints-plastics-polishes...hundreds of other products

MICROSCOPIC PARTICLES of Celite\* do a man-size job of stepping up performance for many of America's leading products. Here is how the unique structure of Celite Diatomite Powders may add more beauty, longer life, greater efficiency to your products, too.

For example, the spiny, irregularly shaped particles contribute surface characteristics which make them the outstanding flatting agent in paints. Again, because of their structure, Celite particles are widely used as a

mild, non-scratching abrasive in finest quality auto, silver and glass polishes. Or consider molded plastics, where the strength and durability of Celite particles add life and beauty to sur-

Moreover, Celite particles in mass have great bulk per unit weight, so they are invaluable for extending, dispersing or fluffing up dry powders. They have high absorptive capacity, too, so they keep powders free-flowing, they serve as a medium for shipping or storing liquids in a dry form.

Which of the many Celite advantages can you use to build product performance or cut production costs? A Johns-Manville Celite Engineer will gladly discuss your problem, without obligation. For his services or more information, simply write Johns-Manville, Box 60, New York 16, N. Y. In Canada, 199 Bay Street, Toronto 1, Ontario.

\*Celite is Johns-Manville's registered Trade Mark for tis



Johns-Manville CELITE INDUSTRY'S MOST VERSATILE MINERAL FILLER

Ozone-a powerful, selective oxidanf138A	High purity graphite in big sizes148B
Flocculation aids142A	Perlauric acid salts148C
All-rubber motor insulation142B	Latex thickener148D
Sodium hydride-in-oil144A	Plastic cable from Mylar148E
Glycerine carbonate144B	Strong vinyl film148F
New nylon, a polymer of caprolactam144C	Brominating agent148G
Isooctyl alcohol market growing146A	Antiozidant for rubber products148H
Synthetic fiber paper148A	Nonselective herbicide
<b>A</b>	age number is also Reader Service code number

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most about the job ozone is doing today. Although pledged to secrecy by many customers, Welsbach will talk about one thing—they're selling a lot of ozone generators of all sizes these days. This, of course, is the surest sign that the company's multi-million dollar investment and 15 years of development work are really starting to pay off.

► Less Costly for Emery–Emery Industries of Cincinnati, Ohio, is giving ozone one of its biggest boosts into the bigtime by using it to oxidize oleic acid to azelaic and pelargonic acids. Here ozone, showing its specificity, cleaves the double bonded oleic neatly at the C<sub>3</sub>-C<sub>10</sub> position, thereby assuring high yields of azelaic and pelargonic acids.

Although tight-lipped Emery isn't saying much about its ozonization process, it's not tough to figure out that, in the quantities being used—we judge Emery's ozone capacity to be in the 3,000-4,000 lb. a day range—ozone is less costly than any other oxidant applicable to the process. This is a highly significant point, for Emery, unlike the fine chemical and pharmaceutical manufacturers, is not working with materials priced at \$100 a lb. or even \$1 a lb.\*

With this successful example of ozone's utility, Emery has opened the door to a simple, economical technique whereby many unsaturated fatty acids may be upgraded. Watch for more activity in this field and others like it, for the chemical world is full of cheap raw materials—terpenes, olefinic hydrocarbons—which can be cleaved with ozone to provide new and potentially useful products.

▶ Pinpoint Oxidation—Merck, Upjohn, Schering and others have successful commercial installations based on the selective oxidation of sterols with ozone to help synthesize hormones like cortisone. Ozonization cleaves the double bonds in a side chain without the need for protecting ring unsaturation, since ozone adds practically quantitatively to the unsaturated chain before attacking the ring.

Again specificity of ozonization and subsequent cleavage are the keys to higher yields of desired products.

Sterol oxidation provided ozone with perhaps its first commercial chemical role when ozone's cost was a good deal higher than it is today. Ozone was able to do this simply because in this field of processing the cost of the oxidant has been a secondary consideration; only relatively small amounts of ozone are required and only expensive basic materials and final products are involved.

For More Information ...



about any item in this department, circle its code number on the Reader Service

Postcard inside the back cover.

- ▶ Not Above Waste Disposal—In Philadelphia a 1,250-lb.-per-day ozone plant is cleaning up 36 million gal. of Schuylkill River water so that residents may have pure water without taste or odor. Elsewhere, a recently patented ozone process is destroying phenols in industrial wastes.
- ▶ Two Out of Three—In cases of a carbon to carbon triple bond, ozone adds in much the same way as with a double bond. However, if hydrolysis or decomposition is carefully carried out, one of the carbon to carbon bonds remains intact and no cleavage takes place. Thus, a keto-aldehyde, diketone or dialdehyde can be formed.
- ► Catalyst for Catalysts Under certain conditions ozone will act as a catalyst or promoter for the reactions of ordinary oxygen, e.g., small quantities of ozone catalyze oxidation of aldehydes to acids in oxygen or air. In another case, the air oxidation of SO₂ to SO₂ in the presence of a manganese catalyst, small amounts of ozone greatly enhance the reaction.

The function of ozone in this and similar reactions is obscure, but does not appear to be an ordinary catalytic effect. Perhaps the ozone keeps the catalyst active, oxidizes catalyst poisons.

► More About Costs—Two examples will help point up the impact of certain cost factors.

1. A 3,000 lb. a day ozone generating plant using recycled oxygen feed can be installed for \$468,000. Depreciation allowance on a

<sup>\*</sup> Azelaic's price has dropped from 54¢ to 43¢ a lb. since ozone took over the oxidation chores.



The three hydroxyl groups of hexanetriol-1, 2, 6 are readily esterified under normal cooking conditions. Alone or in combination with other polyols, hexanetriol-1, 2, 6 reacts with dibasic acids to make polyester resins and alkyd resins with greater flexibility and increased compatibility with other resins. Hexanetriol-1, 2, 6 offers a new approach to the manufacture of polyurethane resins and isocyanate foams. Because of its configuration, limited hygroscopicity (about 40 per cent of glycerol), and solvent properties, it is effective as a humectant-plasticizer for water-dispersible resins. Hexanetriol-1, 2, 6 is now available in commercial quantities. Order now and put this valuable triol to work for you.

#### PROPERTIES OF HEXANETRIOL-1.2.6

Specific Gravity at 20/20°C.....1.1063

Boiling Point at 5mm. Hg ....178°C.

Vapor Pressure at 20°C......<0.01 mm. Hg

Freezing Point .........Sets to a glass below -20°C.

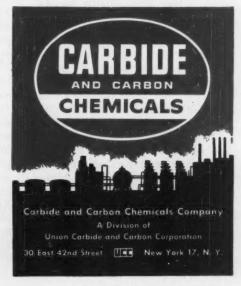
Solubility in Water at 20°C.....Complete

Viscosity at 20°C........2584 cps.

at 40°C........512 cps.

for Further Information

... write the Carbide Office nearest you for the technical bulletin on Triols (F-7779). Carbide also supplies pentanediol-1, 5 and 23 other glycols and polyglycols. In Canada: Carbide Chemicals Company, Division of Union Carbide Canada Limited, Toronto.



ten-year basis, for a 24-hr.-a-day, 360-day-a-yr. operation, will be 4.3¢ per lb. of ozone. Oxygen cost is 5.5¢ per lb. of ozone (assuming a base price of 5¢ in the volume required and adding 0.5¢ for cleaning, drying and cooling recycled feed). Power is required for ozone generation, electrical reactivation of driers and operation of accessory equipment and costs 0.8¢ per kwh. About 4-4.5 kwh. are needed to produce one pound of ozone from oxygen (about 9 kwh. when air is raw material). Maintenance and operating labor charges are low.

Total cost per pound of ozone produced: 13.3¢.

2. The lowest cost ozone is obtained in a plant which has oxygen available as a byproduct of another operation. A 3,000 lb. per day plant using oxygen on a once-through basis can be installed for \$344,000. Assuming oxygen to cost 0.2¢ per lb. of ozone, depreciating as before and assuming other charges to be the same, we find the cost per pound of ozone produced to be only 6.8¢.

It should be noted that a limited operation of 8 hr. a day, 250 day a yr., will boost costs per pound of ozone up to about 28¢ in the first example and to 18¢ in the second.

#### **Floceulation Aids**

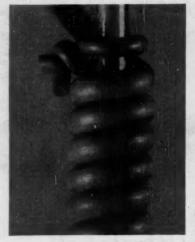
Speed floe growth and settling time, effective in small doses.

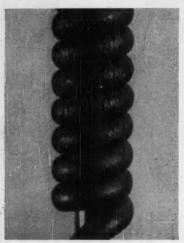
138A

New polymeric polyelectrolytes, tailored for industrial water treatment, increase rate of floc growth and settling time by four to ten times over those possible without polyelectrolyte addition. And the floc produced has greater strength than floc formed without these aids, greater resistance to redispersion by excessive turbulence.

 A high rate sludge blanket coagulator needed 80 ppm. of ferric sulfate and 120 ppm. of lime for satisfactory performance. Addition of 0.5 ppm. of polyelectrolyte enabled 40 ppm. ferric sulfate and 60 ppm. lime to achieve excellent results. Savings in chemicals exceeded polyelectrolyte cost fivefold.

An industrial waste treatment plant handles a total of 250 ppm. of acid, alkali and cyanide waste from a metal finishing operation. Addition of 0.8 ppm. of the polyelectrolyte reduced floc settling time from 30 min. to 5 min.— Cyrus Wm. Rice & Co., Pittsburgh 5, Pa. 142A





Silicone rubber insulation (left) outlasts organic rubber in corona test.

### **Motor Insulation: All-Rubber Now**

Silicone rubber—with all its desirable properties
—is successfully applied to motors and generators.

A long-awaited, all-rubber insulation system for electric motors and generators is today a reality,\* thanks to Allis-Chalmers' engineering and Dow Corning's silicone rubber. Topping the operational benefits: added motor protection, longer motor life, more power per pound of equipment.

Formerly, such materials as mica, resins, asbestos and fiber glass—and combinations of silicones with them—provided insulation of rotor and stator coils. Now, one insulation, a silicone rubber, has been sucessfully applied to electrical equipment. It combines the thermal endurance and moisture resistance of silicone insulations with the flexibility and resilience formerly obtainable only in organic rubbers.

\* Silicone rubber-insulated motors and generators are available in the 2,300 and 4,000-y. class, with higher voltage windings to come. Here are some specific claims for Silco-Flex silicone rubber insulation:

• Thermal conductivity — greater than that of either organic rubber or resinous insulators. Motors can work harder without getting too hot. By contrast, most good electrical insulators are also good thermal insulators and impede the flow of heat from the windings.

 Abrasion resistance – better than that of other insulators. This means less need for totally-enclosed motors in industrial processing.

• Dielectric life—superior to any conventional insulator at temperatures produced in hard-working motors (up to 250 C.).

 Moisture resistance—greater than that of any other flexible insulator.

 Flexibility and resilience withstands mechanical abuse and

NM CH, NO CH3CH2NO

#### THE 3 NITRO

New Stars

to give new to the chemical industry

2-NP CH, CHNO, CH

CH, CH, CH, NO

#### PHYSICAL PROPERTIES

	(Nitromethane) CH <sub>3</sub> NO <sub>2</sub>	NE (Nitroethane) CH <sub>3</sub> CH <sub>2</sub> NO <sub>2</sub>	1-NP (1-Nitropropane) CH <sub>3</sub> CH <sub>2</sub> CH <sub>2</sub> NO <sub>2</sub>	2-NP (2-Nitropropeno) CH <sub>3</sub> CHNO <sub>2</sub> CH <sub>3</sub>
Molecular Weight	61.04	75.07	89.09	89.09
Boiling Point at 760mm, °C	101.2	114.0	131.6	120.3
Azeotrope with Water, bp, °C	83.6	87.1	91.2	88.4
NP in azeotrope, % by weight	77.1	73.6	64.5	73.1
Vapor Pressure at 20°C, mm	27.8	15.6	7.5	12.9
Evaporation Rate, by volume*	139.0	121.0	88.0	110.0
Freezing Point, °C	-29.0	-90.0	-108.0	-93.0
Specific Gravity at 20/20°C	1.139	1.052	1.003	0.992
Density of Vapors (air = 1.00)	2.11	2.58	3.06	3.06
Weight per U.S. Gallon at 68°F, lb	9.48	8.75	8.35	8.24
Coefficient of Expansion, per °F	0.00064	0.00062	0.00056	0.00058
Refractive Index, np at 20°C	1.3818	1.3916.	1.4015	1.3941
Surface Tension at 20°C, dynes/cm	37.0	31.3	30.0	30.0
Heat of Vaporization at 30 °C,				
calc., cal/g	143.3	124.8	107.3	104.4
Heat Capacity at 25°C, cal/g	0.422 <sup>30°C</sup>	0.441	0.471	
Dielectric Constant at 30°C	35.76	28.00	23.22	25.48
Ignition Temperature, °F	785.0	778.0	789.0	802.0
Flash Point, °F (Tag Open Cup)	112.0	106.0	120.0	103.0
pH 0.01M Aqueous Solution at 25°C	6.4	6.0	6.0	6.2
Solubility in Water at 20 °C,				
% by volume	9.5	4.5	1.4	1.7
Solubility of Water in NP at 20°C,				
% by volume	2.2	0.9	0.5	0.6
*N-Butyl Acetate = 100				

#### NP DERIVATIVES ALSO AVAILABLE

AB (2-Amino-1-butanol) AEPD (2-Amino-2-ethyl-1, 3-propanediol) AMPD (2-Amino-2-methyl-1, 3-propanediol) AMP (2-Amino-2-methyl-1-propanol) NB (2-Nitro-1-butanol) NEPD (2-Nitro-2-ethyl-1, 3-propanediol)

NMPD (2-Nitro-2-methyl-1, 3-propanediol)

NMP (2-Nitro-2-methyl-1-propanol) ALKATERGES

TRIS AMINO (Tris [hydroxymethyl] aminomethane)
TRIS NITRO (Tris [hydroxymethyl] nitromethane)
HAS (Hydroxylammonium Acid Sulfate)

HC (Hydroxylammonium Chloride) HS (Hydroxylammonium Sulfate)

SAMPLES ON REQUEST

Here are the Nitroparaffins - NM(Nitromethane), NE(Nitroethane), 1-NP(1-Nitropropane) and 2-NP(2-Nitropropane). These four NP's have a potential range of usefulness unequalled by any other group of organic chemicals! CSC's new Nitroparaffin plant at Sterlington, La., will be on stream with increased volume starting August of 1955.

In many cases, they provide better and more economical methods of manufacturing well-known and widely used industrial chemicals. However, the majority of the reactions yield entirely new compounds. There are practically an unlimited number of products which can be prepared from the NP's. As solvents, they present an unusual combination of properties they are medium-boiling, mild-odored and, most important of all, they have strong solvent power for a wide variety of substances, including many coating materials, waxes, resins, gums, dyes, fats and oils, and numerous organic chemicals. The CSC Nitroparaffins are chemistry's newest stars. They give new direction to the production of old products and the development of new.

ERCIAL SU

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NDUSTRI

stresses caused by overloading, rapid starting or stopping of the equipment.

• General resistance — withstands most atmospheric contaminants, weak acids, alkalis, lube oils, corona (see cut) and weathering.— Allis-Chalmers Manufacturing Co., Milwaukee, Wis., and Dow Corning Corp., Midland, Mich.

142B

#### Sodium Hydride-In-Oil

Easier, safer handling, yet greater effectiveness in reactions.

Of significance to the chemical industry is a new form of sodium hydride—an oil dispersion of micron-range  $(5-50\mu)$  particles.

Sodium hydride-in-oil is much more effective than dry NaH because of its particle size and because the oil coating prevents surface oxidation of the NaH crystals (formation of a hard shell of sodium hydroxide insoluble in inert solvents and which slows down or prevents condensation reactions).

Finely-divided, oil dispersed sodium hydride sparks reactions, usually requiring days to complete, to completion in a matter of hours or occasionally minutes. Two other benefits: yield is frequently greater; the reaction temperature can usually be decreased.

The oil coating also protects the reactive NaH crystal surfaces when handled in air. Dusting is eliminated and fire hazards minimized.

Convenient to use as well, this ready-made NaH dispersion needs no preparations before use; it can be poured in air, pumped and metered. High concentrations of NaH-in-oil can even be screw-fed.

Sodium hydride resembles sodium and sodium alcoholates in performing as a condensing agent in the acetoacetic ester, Claisen, Stobbe and related condensations, but with marked advantages (even more apparent now with the oil-dispersed form). NaH is more powerful and generally more rapid; no great excess is needed; no reacting alcohol need be distilled to force condensation and no foreign alcohol is formed; side reactions are minimized; and reduction is kept to a minimum.—Metal Hydrides, Inc., Beverly, Mass.

144A

#### **Glycerine Carbonate**

Cyclic glycerine derivative is good source of reactive epoxide, glycidol.

A new, commercial cyclic glycerine derivative, glycerine carbonate, is a colorless, odorless mobile liquid, miscible with water and low molecular weight solvents.

Some possible applications:

• As a source of the reactive epoxide, glycidol, a material not



Film . . .



Bottles . . .



Intricate parts . . .

#### New Forms and New Uses for New Nylon

Nylon 6, a new polyamide derived from caprolactam, has the properties to put new life into nylon molding techniques. Called Plaskon 8200 by the manufacturer, nylon 6's chief asset is its unusually high molten viscosity. For, unlike conventional nylon, which has a sharply defined melting point and changes

rapidly from a tough solid to a watery fluid, Plaskon 8200 retains sufficient body at melt temperatures to be conveniently extruded. The new nylon's second big asset—its controllable crystallinity—allows fabricators to vary the finished product's final physical properties in thin sections, even to the extent of form-

ing clear products. Combination of these two Plaskon assets makes possible the extrusion of clear film, the blow-molding of bottles and the formation of intricately-shaped objects. New nylon's price—about \$1.45/lb.—is competitive.—Barrett Div., Allied Chemical & Dye Corp., New York 6, N. Y. 144C

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- for better compounding!
- Powdered to mix better with other finely divided materials
- Faster dissolving
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- Attractively priced
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commercially available previously.

 As an extractive solvent, e. g. to separate weak aromatic bases from hydrocarbons.

 In reactions with ammonia or strong primary and secondary amines—without loss of carbon dioxide—to produce glyceryl ester of carbonic acid and its N-substituted derivatives.

In hydroxyalkylation reactions—particularly with phenols—which yield aryl ethers of glycerine, and with fatty acids to give glycrides.—Jefferson Chemical Co., New York 16, N. Y.

since then). Gulf Oil started up next in 1953 at Port Arthur, Tex. (Chem. Eng., Aug. 1954, p. 113-114), has a rated capacity now of about 10 million lb./yr. of isooctyl alcohol, also by the Oxo process.

There may soon be a fourth entry: Carbide and Carbon's big Oxo unit at Texas City, Tex., with a reported capacity of 60 million lb. of Oxo "chemicals" a year, plans isooctyl production soon.

Output of Standard of Indiana's plant will be channeled into various uses.\* Primary outlet for isooctyl alcohol is the manufacture of vinyl plasticizers by conversion of the alcohol to the desired esters. 
Priced as it is at 21¢ a lb., isooctyl has a small edge over the more common 2-ethylhexyl alcohol which gives similar plasticizers.

Isooctyl phthalate ester, because of its all-round properties, is the most popular. Mixing with decyl phthalate gives a less volatile prod-

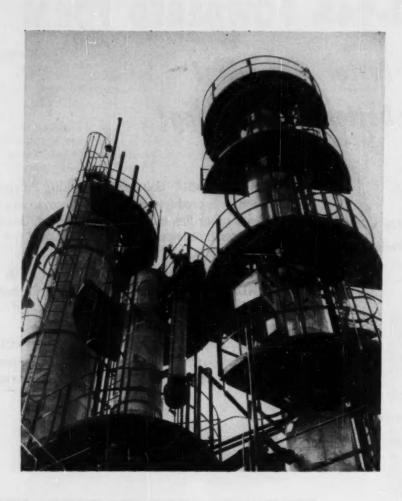
Other isooctyl esters—adipate, sebacate, azelate—coming into their own are usually blended with less expensive esters like phthalate, phosphate, etc., to provide a plasticizer with better low temperature properties and lower viscosity. The phosphate ester by itself imparts good low temperature characteristics as well as improved flame resistance to vinyl products.

Many of these esters can be used with other resins and elastomers, e.g. the adipate in nitrile rubber.

Substantial amounts of isooctyl alcohol go to produce nonvolatile esters of 2,4-D and 2,4,5-T acids for use as brush killers.

In the lubricant field, isooctyl sebacate, azelate, adipate, pelargonate and phosphate perform as heat stable, noncorrosive synthetic lubricating oils, hydraulic oils and greases for jet engines. Barium, zinc and other alkali metal additives for motor oil are produceable from isooctyl alcohol.

Isooctyl alcohol offers promise as



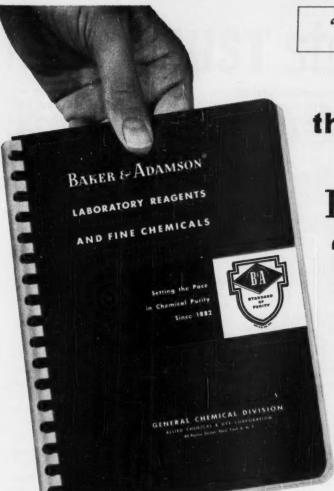
#### More Iso From Oxo

Third isooctyl plant goes on stream to boost total domestic capacity to 50 million lb./yr.

Springing loose their first shipment of isooctyl alcohol recently from a new 10 million-lb.-per-year Oxo plant, at Wood River, Ind., Standard Oil of Indiana lays strong claim to a share of the market. And a good-looking market it is, too, what with better than 50 million lb./yr. of capacity courting its favor.

Esso Standard was first in line, in 1949, at Baton Rouge, La., with a 30 million lb./yr. Oxo isooctyl operation (increased substantially

<sup>\*</sup>Since the plant and process are flexible, Standard plans to produce other high bolling alcohols, all with related end uses. Decyl will definitely be made, nonyl may come soon, others are under consideration.



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a basis for wetting agents and nonionics tailored to the growing and increasingly specific surfactant field.

Standard of Indiana's product is a 99% pure mixture of several primary isomeric octyl alcohols, dimethyl hexanols being predominant. Color is good and boiling range is narrow (less than 5 C.).

146A

#### Synthetic Fiber Paper

Three to ten times stronger than paper from pulp or rags.

Dacron, nylon and Orlon paper have been made experimentally for the first time. What's more important, though, is the fact that the virtues of the synthetic fibers -chemical resistance, high strength, resistance to molds, bacteria and light-have been successfully transplanted to the papers made from

The new papers are 3-10 times stronger - and have 200-times greater resistance to folding-than paper made from conventional pulp or rags.

Manufacture of synthetic fiber paper is similar for the most part to conventional paper making. Fibers are cut in short lengths, slurried with water and formed into sheets on a wire screen. The sheets are dried, impregnated with bonding agents-inorganic salts like calcium bromide or synthetic polymers similar to the fiber under treatment-and finally heated and pressed to finished paper.

Du Pont thinks the synthetic fiber paper can be made commercially, is making details of the experimental work available to the paper industry.-E. I. du Pont de Nemours & Co., Inc., Wilmington 98, Del. 148A

For More Information . . about any item



in this department, circle its code number on the Reader Service Postcard inside the back cover.

#### Briefs

High purity graphite-total ash content of 0.003% or less-is available in diameters up to 21 in. and up to 43 in. in length. This purity is close to that previously achieved only in small-diameter, high purity, spectrographic rods. Uses for new graphite thus far: as crucibles and boats in the final purification of germanium; as electric furnace heating elements having materially longer life at high temperatures. - Stackpole Carbon Co., St. Marys, Pa.

148B

Salts of perlauric acid combine in one compound the properties of a soap and germicide. Various germicidal soaps on the market today are usually mixtures of a soap and germicide. Alkaline perlauric salt solutions show the surface-active properties of lauric acid soaps and have greater germicidal power than sodium laurate.-Becco Chemical Div., Food Machinery and Chemical Corp., Buffalo 7, N. Y.

Latex thickener, at concentrations of 1% or less, is 3 to 20 times more effective-as measured by viscosity of the final latex composition-than currently available thickeners. Latices thickened with Acrysol G-110, an ammonium polyacrylate solution, have good storage stability, do not undergo phase separation or creaming. Viscosity stays constant with aging, is unaffected by high pH and temperatures. Acrysol G-110 functions in the presence of sodium, calcium and magnesium salts.-Rohm & Haas Co., Philadelphia 5, Pa. 148D

Plastic cable made from Mylar, the strongest of all polyester films, has unusual abrasion resistance, will safely handle much larger work loads than fiber ropes. Mylar cable has high mechanical and impact strength, is impervious to water, highly resistant to chemicals and solvents and is thermally stable from 70 F. to

more than 300 F. It may be spliced, as is fiber rope, and cut by the "hot knife" method; cut ends will heat seal to prevent raveling. - Reynolds Industries, Cleveland, Ohio.

Vinyl film, thicker and stronger than any flexible, transparent vinyl film now produced commercially-that's the claim for Krene cast film. Ranging in thickness from 0.005 in. to 0.010 in., Krene has high abrasion resistance and can be flexed and folded without cracking .-Bakelite Co., New York 17, N. Y. 148F

Organic brominating agent that's less hazardous and more useful in many cases than bromine and other brominating agents is dibromodimethyl hydantoin, (active bromine content of 54%). This is the first time this type of organic brominating agent has been commercially available.-Glyco Products Co., Inc., New New York 1, N. Y.

Antiozidant designed to halt surface cracking of rubber products due to ozone attack, UOP 88 is effective even with GR-S compositions which are particularly ozone-susceptible. UOP 88 performs well in dynamic useswhere coating-type antiozidants fail-and where relatively high temperatures prevail. - Universal Oil Products Co., Des Plaines, TIII.

A nonselective herbicide, Baron, has been proved highly effective against almost all perennial grasses, as well as herbaceous plants, on which its been tested. Chemically, Baron's active component is unique: both parts of the two-part molecule exert herbicidal action, each toxic to its own range of vegetation. Other herbicide molecules are formulated with more or less inert substances. - Dow Chemical Co., Midland, Mich. 148T

## If you must stop Corrosion KEL-F PLASTIC WILL

KEL-F Plastic Molded
and Fabricated
Valve Linings,
Valve Diaphragms,
Gaskets, Ring Seals,
Gauge Crystals,
KEL-F Dispersion Couted
or Laminated Lined
Tanks, Vessels, Reactors,
Piping and Tubing
can protect your
plant equipment against

chemical corrosion

KEL-F Fluorocarbon Plastic is the best non-permeable, corrosion-proof material available today. It is inert to virtually any type of chemical attack—including mineral acids, oxidizing agents as well as strong caustics. When nothing else will protect equipment, KEL-F Plastic usually will.

HERE ARE SOME OF ITS OUTSTANDING CHARACTERISTICS:
Temperature Tolerance

Exhibits satisfactory properties over a temperature range of approximately 710°F. (-320°F. to 390°F.)

**High Compressive Strength** 

Pressures of 8,000 psi result in only 4% to 5% permanent set. Line seals are retained longer when gaskets and O-ring seals are made of KEL-F Plastics.

#### Non-Adhesive

KEL-F Plastic is non-wetting even after long periods of immersion. Surface is anti-fouling when in contact with even the most viscous liquids.

KEL-F Plastic is a thermoplastic and easy to fabricate. It is readily molded by extrusion, transfer and injection. Available in sheets, rods, tubing and film, it can be fabricated, heat formed, machined and heat-sealed by a growing list of experienced fabricators.

#### **New! KEL-F Plastic Dispersions**

KEL-F Plastic Dispersions have been developed for bakecoating of metallic surfaces that must be corrosion resistant, anti-adhesive and electrically non-conductive. These Dispersions can be applied by spraying, spreading or dipping.

The full story of what KEL-F will do for you is worth having. Write or call for additional information.



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Chemical Manufacturing Division, P. O. Box 469, Jersey City, N. J.

SUBSIDIARY OF PULLMAN INCORPORATED

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#### if the average number of Traylor Kilns







#### built each year were placed end to end

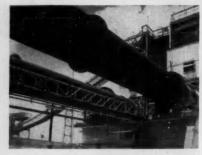






they would extend almost half a mile







#### THAT MEANS A BETTER ROTARY KILN INSTALLATION FOR YOU

Traylor has averaged almost 1 Rotary Kiln installation a month for the past 14 years. With more than 33,000 feet of Rotary Kiln construction, Traylor has the biggest backlog of experience in the field to draw upon in designing a kiln for practically any thermo-processing operation.

Traylor Kilns have been built in sizes from  $3\frac{1}{2}$  to 12 in diameter; from 40 to 425 in length. They are being used to process some 21 different products.

Of the 152 Traylor Kilns built since 1941, no more than any 3 or 4 were alike. Most of these were built for former customers after the initial Traylor installation recoved the advantage of "Traylor made" equipment.

proved the advantage of "Traylor-made" equipment.

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TRAYLOR ENGINEERING & MFG. CO. 751 Mill St., Allentown, Pa.

Canadian Mfrs.: Canadian Vickers, Ltd., Montreal, P. Q.



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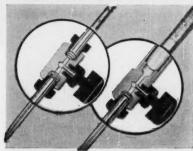
PROPERTY AND APPLICATION DATA ON THESE VERSATILE ENGINEERING MATERIALS: "ZYTEL," "ALATHON," "TEFLON," "LUCITE."



- NO. 5

1955

#### New needle-valve burettes use "TEFLON" to prevent leakage, sticking, contamination

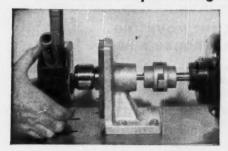


Two types of needle-valve burettes with valves made of Du Pont "Teflon" tetrafluoroethylene resin. (Manufactured by the Emil Greiner Company, New York City, N. Y.)

A new line of needle valve burettes, recently introduced, can perform titrations for very fine micro measurements without the annoyance of stopcock adjustments. The valve is made in part of Du Pont "Teflon" tetrafluoroethylene resin. "Teflon" resists breakage, prevents leaks and eliminates grease contamination in the stopcock. This engineering material is inert to all industrial chemicals. Its working temperature range extends from -450°F. to 500°F.

Use the coupon below for more information on versatile Du Pont "Teflon."

#### Pump body block molded of ALATHON® simplifies design



This patented "Flex-i-liner" pump features a body block of molded Du Pont "Alathon" polyethylene resin. "Alathon" is tough, non-contaminating, and resists corrosive fluids. It resists abrasive slurries.

The manufacturer has been able to reduce parts and increase pump efficiency with the body block of "Alathon." Pump design eliminates stuffing boxes and shaft seals, so external leakage from these sources is avoided. The pump is self-priming—needs no check valves or gaskets. And because "Alathon" is lightweight (sp.gr. 0.92), the pump is easier to handle.

Can you utilize versatile Du Pont "Alathon" for your operation? Use the coupon for full property data. (Pump manufactured by Vanton Pump and Equipment Corp., New York City.)

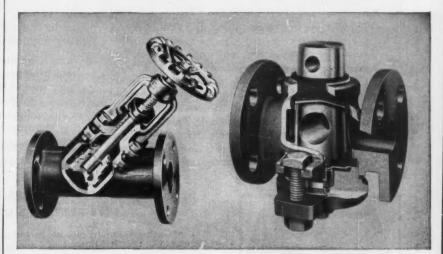
## Disc Rings and Sleeves of TEFLON® Prolong Valve Life

Disc rings and reinforced sleeves of Du Pont "Teflon" tetrafluoroethylene resin give a tight seal against pressure and vacuum. They have good impact strength and abrasion resistance under normal conditions of speed and load. Toughness and flexibility are retained at temperatures as low as  $-450^{\circ}$ F. "Teflon" gives continuous service up to  $500^{\circ}$ F.

"Teflon" has zero water absorp-

tion—won't shrink, crack, swell or harden because of moisture. And it's inert to all chemicals except molten alkali metals and fluorine at elevated temperatures and pressures.

These remarkable properties have reduced maintenance time, increased service life and efficiency for Durco Type F and Types J and K "Y" valves manufactured by The Duriron Company, Inc., Dayton, Ohio.



"Y" valve has disc ring and stem packing of Du Pont "Teflon" tetrafluoroethylene resin for longer service, positive sealing. Durco Type F valve with sleeve of "Teflon" avoids metal-to-metal contact, and assures dependable service with no galling, no sticking.

#### NEED MORE INFORMATION?

CLIP THE COUPON for additional data on the properties and applications of these Du Pont engineering materials.

"Teflon," "Alathon."
"Zytel" and "Lucite" are
registered trade-marks of
E. I. du Pont de Nemours
& Co. (Inc.).

E. I. du Pont de Nemours & Co. (Inc.), Polychemicals Department Room 256, Du Pont Building, Wilmington 98, Delaware In Canada: Du Pont Company of Canada Limited, P.O. Box 660, Montreal, Quebec.

Please send me more information on the Du Pont engineering materials checked: 

"Teflon"\* tetrafluoroethylene resin; 

"Alathon"\* polyethylene resin; 

"Zytel"\* nylon resin; 

"Lucite"\* acrylic resin. 
I am interested in evaluating these materials for

NAME

COMPANY POSITION

STREET

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## agner Type DP Motors



Wagner Type DP Motors tected by rugged, corrosion cast iron frames, smoothly so that no moisture can them. Motor feet are cash tegral part of the frame fair strength and rigidity.

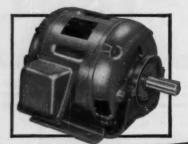
Enclosures are drip-proof intakes are located at t the endplates - air out cated at the base of th on each side. Specially baffles provide protes stator windings.

The Wagner line of polyphase, drip-proof general purpose motors-rerated to the new NEMA Standards-pack more power into smaller frames, but give you the same high Wagner Quality and long life performance that have made Wagner Motors "the choice of leaders in industry" for many, many years. These new Wagner Motors are fully protected in the ball bearing models. Their construction makes them completely drip-proof - and virtually splash-proof. The extra large, diagonally split conduit box makes wiring easy. Smaller size

and lighter weight means more economical handling and installation.

These new rerated Wagner Motors retain the features desired by plant engineers and maintenance men. They will operate for years without regreasing. But . . . when lubrication is necessary or desirable, you can lubricate these motors because they are provided with two lubrication openings.

Bulletin MU-202 gives full information—write for your copy today.



#### **AVAILABLE WITH RESILIENT MOUNTING** -SLEEVE BEARINGS UP THROUGH 5 HP.

These Wagner standard motors, in ratings up through 5 horsepower, can be used for specialized applications because they are available in sleeve bearing models with endplates that will take resilient mounts.

You can look to Wagner for a complete line of standard motors for specialized applications. The wide range of types and sizes permit the selection of a standard motor for almost any need.

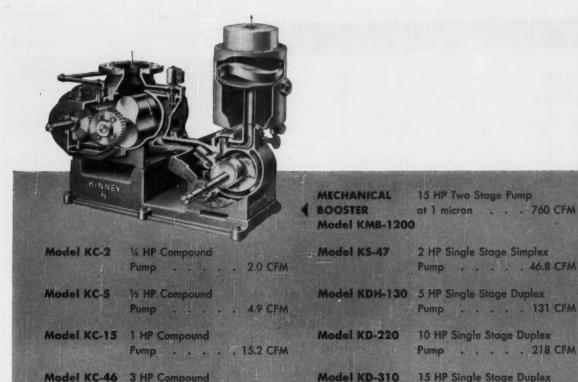


#### Wagner Electric Corporation

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Model KD-485

Model KD-780

There's no economy in buying the wrong size vacuum pump. That's why Kinney has developed such a broad range of mechanical high vacuum pumps... more models, capacities, and types than any other line on the market.

Pump . . . . . 46.0 CFM

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1/2 HP Single Stage Simplex

11/2 HP Single Stage Simplex

Model KS-13

Model KS-27

For full information on Kinney Single Stage, Compound, and Mechanical Booster Vacuum Pumps, write

today for Bulletin V-54 . . . or tell us about your process problems.

Pump . . . . . . 311 CFM

. . . . 486 CFM

. . . . . 780 CFM

25 HP Single Stage Duplex

40 HP Single Stage Duplex

Kinney District Offices in Boston, New York, Philadelphia, Cleveland, Chicago, and Los Angeles are all competently staffed to discuss vacuum with you. Los Angeles office carries complete stock and has full service facilities.





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No matter how varied or complex the related facilities involved in the design and construction of your new plant, Kaiser Engineers has the breadth of experience and qualified personnel to assume sole responsibility for the design and construction of the complete project.



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is perhaps the most diverse and complicated of industrial activities. In the design and construction of plants producing alumina, aluminum, diatomaceous earth, magnesia, coke by-products and cryolite, the KE team of engineering specialists has earned an outstanding reputation.

This reservoir of engineering talent is available to serve your firm. Call us for preliminary discussion of your problem.

Write today for your copy of the KE chemical plants and processing brochure. Ask for No. 101.



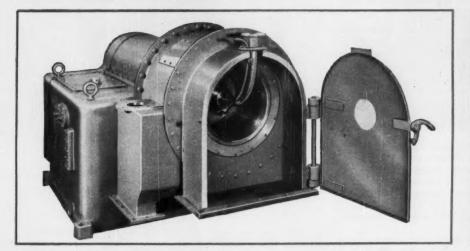
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- . HENRY J. KAISER CONSTRUCTION CO. . HENRY J. KAISER COMPANY (Canada) LTD., MONTREAL . KAISER ENGINEERS INTERNATIONAL, INC.

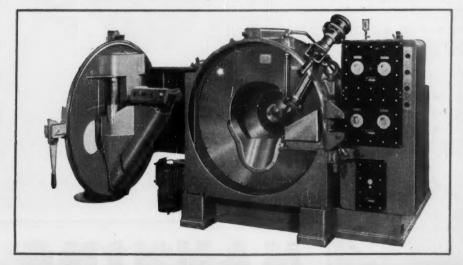
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OF FILTERABLE
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CHEMICAL MACHINERY DIVISION . SAGINAW, MICHIGAN

Operation of Plant-Scale Installations\*

DEMONSTRATES BENEFITS OF

ELECTRONIC PROCESS CONTROL

'American-Microsen' Electronic Process Control Installations Now In Successful Operation Have Proved The Reliability, Speed, Sensitivity And Accuracy Of This Modern Concept Of Process Instrumentation.

This is the electronic process control system that now makes it practicable to utilize the capabilities of process equipment far more fully than ever before. Revealed in actual operation of plant-scale installations are the much discussed benefits of this new approach to plant instrumentation.

Used to measure, indicate, record and control process variables (pressure, differential pressure, temperature, level flow, pH, gas analysis, etc.), these installations exhibit every essential to improve product quality, increase operational efficiency and plant productivity.

Only the 'American-Microsen' System provides:

Lag-free signal transmission using the simplest communication lines.

Extremely fast, accurate measurements and control responses—sensitivity impossible to duplicate in other types. Installation of all controllers in the instrument room any distance from the process—even 30 miles or more.

High stability that permits use of narrower proportional bands.

Freedom from dirt, leakage, freeze-ups and other transmission line problems.

Standardized control components interchangeable at the panel and plug-in components on each instrument.

Adaptability — more than one input circuit can be fed into a controller for cascading or programming.

DC signal that can be fed to potentiometer recorders, digital read-out systems, monitors, computers, etc., so that process and operational data are automatically reduced to quickly usable form.

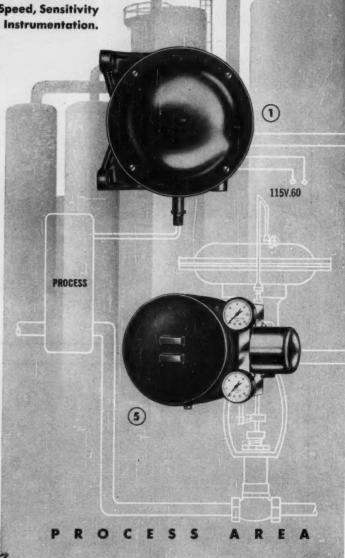
Flexibility — output signal can be fed in series to any number of receivers, without impairing accuracy. Components can be mounted anywhere convenient to operating and servicing.

Electrical circuitry makes possible unusual control and measurement functions not available in mechanical systems. Minimum installation or maintenance investment in transmission lines, air compressors, filters, pressure regulators, dryers.

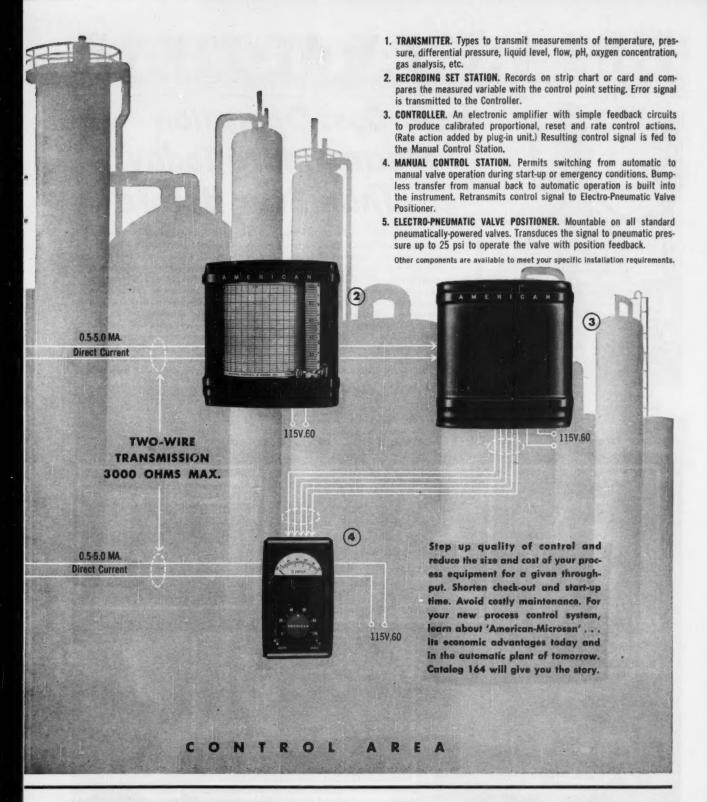
\*Names and locations of installations available upon request.

THE 'MICROSEN' BALANCE, the "nerve center" of 'American-Microsen' Instruments, is a simple, electro-mechanical servo-mechanism. It operates on the force-balance principle to produce a highlevel direct current signal that is not affected by any normal electrical or ambient condition.





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INDUSTRIAL CONTROLS DIVISION

Stratford, Connecticut

MAKERS OF 'AMERICAN-MICROSEN' ELECTRONIC TRANSMITTERS, INDICATING OR RECORDING SET STATIONS, CONTROLLERS, MANUAL CONTROL STATIONS AND ELECTRO-PNEUMATIC VALVE POSITIONERS.



### IN TERMANDELLA

Type GFR "INTERNATIONAL"
Slow Speed Turbine Type Mixer

Courtesy, International Minerals and Chemical Corp., Bartow, Fla. Weldforged Grating by Kerrigan Iron Works

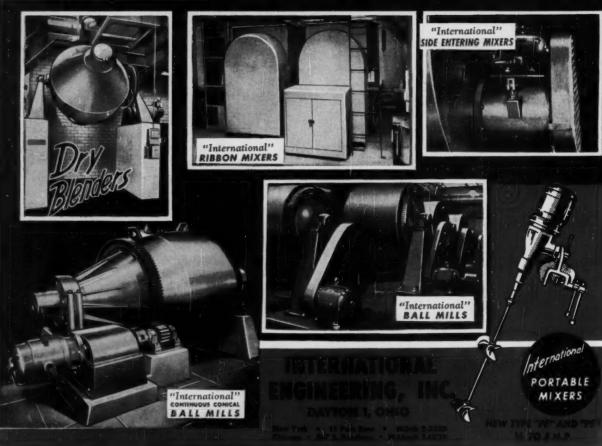
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WHO CARES ABOUT COMPETITION? You do, and so does everyone else. You cannot ignore the fact that somebody, somewhere, is after the business that has been normally yours. In the final analysis as of today, it's lower operating costs that will enable you to stay in a competitive market and show a profit.

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INTERNATIONAL Sales Engineers are available, without cost or obligation, to check over your present facilities, and make whatever recommendations are necessary to reduce costs and put your plant in a more flexible and stronger compelitive position. Why not call us, or write for Technical Bulletins and full information on any of your processing problems.

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## Look to COOK for Better VALVE PLATES!

R.S.V.P.

Really
Superior
Valve

Plates are another outstanding product of the C. Lee Cook Company.

Notice that the slots are milled, and that the surface is ground. Look at the square, smooth edges—made possible by the excellent machining qualities of the phenolic-resin surface sheets. Inspect the edges carefully under the magnifying glass and you'll see that they're absolutely free of any cracks, crevices or crazing to cause erosion!

The cross-section, right, shows the surface sheets of pure cotton fabric, possessing finest machining qualities. Note the strong core, too — it's designed to withstand constant flexing!

R.S.V.P.!—use the coupon for more information about Cook's Really Superior Valve Plates!

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Title



#### Unibestos means stronger, longer lasting pipe insulation

Amosite...the South African asbestos with long, strong, resilient fibers gives Unibestos Pipe Insulation greater strength and superior insulating ability. Built for durability, Unibestos resists both vibrations and shock, and is unaffected by most acid and chemical fumes. When lines must be relocated and replaced, Unibestos can be removed and reapplied with little or no loss of material.

#### Single Layer Construction Cuts Installation Costs

Unibestos is easily handled—can be cut, mitered, for quick installation, requiring little pointing of joints. Unibestos reduces scaffolding needs, and speeds completion of job.

#### Unibestos Reduces Heat Loss

Tests prove that Unibestos single-layer pipe insulation

provides greater protection against heat loss than other nonfibrous double-layer insulations.

#### STANDARD PRODUCTION SIZES

Unibestos Pipe Insulation is regularly made in 3-foot lengths for pipe sizes from ½" through 24", in standard thicknesses through 5". Unibestos Block Insulation is made in 6", 12", 18" or 36" widths and in thicknesses from 1" through 3" in ½" increments.

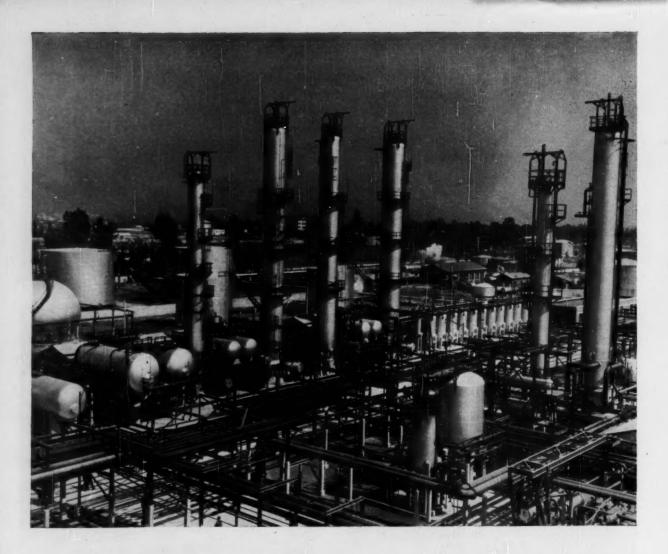
For complete information, write for Descriptive Bulletin 109C.



#### UNION ASBESTOS & RUBBER COMPANY

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### why TITANIUM stops corrosion losses...

Titanium owes its exceptional corrosion resistance to a tightly adherent, protective, stable film of oxide that forms on its surface. Protection is increased when oxygen or oxidizing agents come into contact with this film. That's why many commercial solutions have little corrosive effect upon titanium, since they, or oxidizing impurities in them, actually help to inhibit attack.

Titanium is remarkably immune to stress corrosion ... erosion corrosion ... corrosion fatigue ... intergranular corrosion ... or galvanic corrosion, including corrosion cells.

What's more, in vital parts, titanium is often the least expensive material you can use. Costly valves, pumps and fittings, for example, stay in service many times longer when they are made of titanium. That means fewer replacements . . . less down time—lower over-all cost.

REM-CRU titanium is now available in all standard mill forms... and our engineers are ready to help you make the most profitable use of it in your plant.

To keep abreast of the latest developments on this vital metal, write to Dept. C6 for the Rem-Cru Review — a free periodical presenting the latest technical data on titanium alloys.

#### REM-CRU TITANIUM

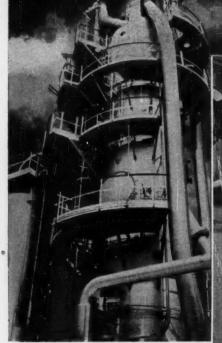
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#### I-R TURBO-BLOWER

supplies 13,800 cfm for

### NEW CAT CRACKER

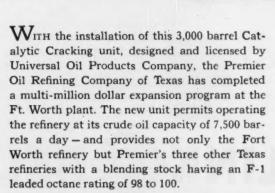
at Premier's Fort Worth Refinery



"Photo, courtesy of Universal Oil Products Company"

Premier's new 3,000 barrel UOP Fluid Catalytic Cracker.

Ingersoll-Rand steam Jurbine driven
Turbo-Blower, rated 13,800 cfm,
46.3 psia discharge.



Air for the new Cat Cracker is supplied by the Ingersoll-Rand steam turbine driven Turbo-Blower shown above, which delivers 13,800 cfm at 46.3 psia discharge. Other I-R equipment serving Premier's Fort Worth Refinery includes three 165-hp JVG gas-engine-driven compressors, and a number of I-R centrifugal pumps.

Wherever dependability and economy of operation must go hand-in-hand, it pays to specify Ingersoll-Rand for your process equipment requirements. Call your I-R engineer for complete details.

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COMPRESSORS • AIR TOOLS • ROCK DRILLS • TURBO-BLOWERS • CONDENSERS • CENTRIFUGAL PUMPS • DIESEL AND GAS ENGINES

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Link-Belt "CA" Vibrating Screen and non-clogging spray nozzles are combined for efficient washing and sizing.

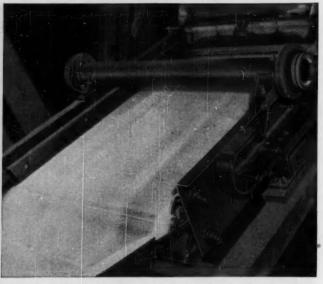


For high-capacity screening of a broad range of materials—Link-Belt "CA" Vibrating Screens are your answer. Concentric Action of vibrator mechanism imparts positive, uniform, circular motion to every square inch of the screen-

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dewatering. Made in a complete range of sizes to suit all plant capacity requirements single, double or triple decked.

Call your nearest Link-Belt office or write for new Book 2554.



Here fine silica sand is effectively sized by a double-deck Link-Belt "UP" Unbalanced Pulley type vibrating screen.



For economical separation of light to medium weight materials—choose Link-Belt "UP" Vibrating Screens. Positive, high-frequency action over entire area of cloth provides maximum sizing opportunity for every particle.

Even on the smallest cloth sizes, blinding is virtually eliminated. And you'll like the lower power and maintenance costs resulting from two-bearing simplicity. "UP" screens are available in open, semi-enclosed, or totally-enclosed types,

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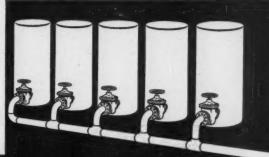
VIBRATING SCREENS

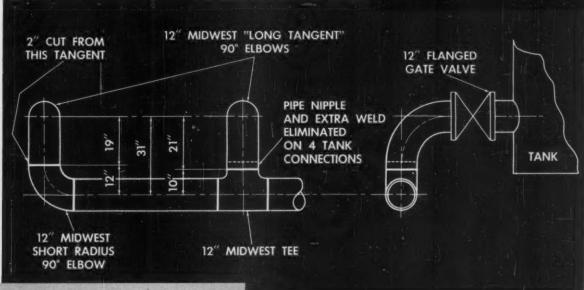
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### MIDWEST "LONG TANGENT" ELBOWS

\$156<sup>20</sup>

On This Welding Piping





MIDWEST "LONG TANGENT" ELBOWS COST NO MORE THAN OTHER ELBOWS



#### The Problem:

To connect the five tanks shown in the sketch at top to a common 12" header.

#### The Difficulty:

The center-to-outlet dimension of the 4-12'' tees is only 10'', while the shortest elbow available measures 12'' center-to-end. Thus, if standard long radius elbows are used next to the five tank valves, four short nipples and four extra 12'' welds would be required.

#### The Solution:

By using Midwest "Long Tangent" elbows as shown in the blueprint, the expense of the four extra nipples and welds was eliminated at the cost of just one cut! The actual net savings made by "Long Tangent" elbows on this job was \$156.20.

Remember—Midwest "Long Tangent" elbows cost no more than regular elbows! For further information, write for Catalog 54.

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6820



Low-cost "Virginia" Liquid Sulfur Dioxide (SO<sub>2</sub>) has met the rigorous requirements of over 40 diversified industries. Our staff has successfully cooperated in applying it to products or processes—as a reducing, bleaching, neutralizing, or preservative agent; reaction medium, pH control or antichlor.

"Virginia's" position as America's Number One producer of SO<sub>2</sub> largely stems from 35 years of accumulated know-how always available to our customers, plus unequaled production and shipping facilities, which always

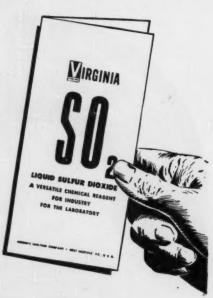
assure prompt and dependable deliveries in any quantity—a pound or a tank car.

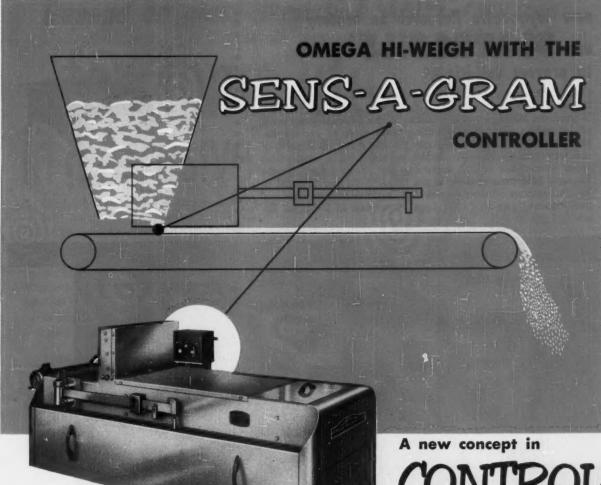
If there's the remotest possibility that an application of our SO<sub>2</sub> can save you time or money, improve efficiency, or upgrade products in your plant or mill, we'd like to look into it. Send today for our SO<sub>2</sub> folder—or ask to have one of our experienced field men call for consultation.

Industrial Department, VIRGINIA SMELTING COMPANY, Box 21:, West Norfolk, Virginia.



Field Offices: NEW YORK • BOSTON • DETROIT • CHICAGO • ATLANTA • ASHEVILLE Available in Canada and many other countries





- 1. Positive drive for positive action.
- 2. Proportional correction made easy by Sens-A-Gram.

ADVANTAGES

- 3. Built-in 100 to 1 Variable Speed Transmission.
- 4. Proportional agitation in the feeder hopper.
- 5. Available with Rotolock for floodable materials.
- 6. Built-in sampling gate.
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for feeding dry materials by weight

Never before has a weighing feeder attained the accuracy of the OMEGA HI-WEIGH - the new feeder with the revolutionary SENS-A-GRAM CONTROLLER. Because of this simple mechanical controller, the OMEGA HI-WEIGH provides repeat accuracy well within  $\pm 1\%$  ... in fact, tests prove deviation from actual weight is often virtually unmeasurable. If your processes involve feeding and proportioning dry materials . . . either by batch or continuous methods . . . you cannot afford to overlook the OMEGA HI-WEIGH with its SENS-A-GRAM CON-TROLLER. Write for Bulletin 37-M1, today. Omega Machine Co., 369 Harris Ave., Providence 1, R. I.

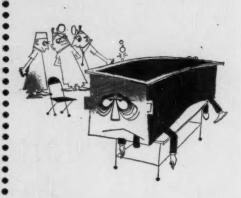
### MEGATHE LAST FEEDERS

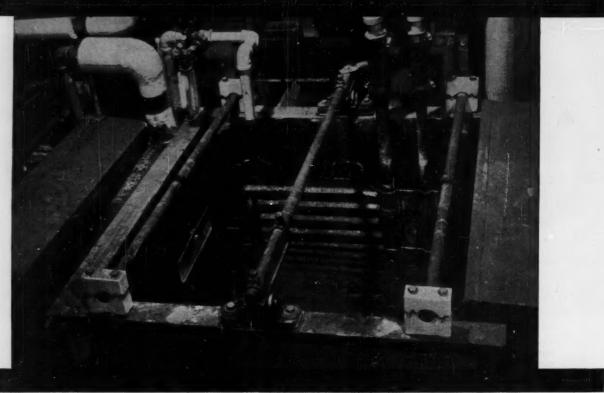
DIVISION OF B-I-F INDUSTRIES, INC.



## new Wyandotte Research Laboratory uses **PLATECOILS**to prevent coil-itis \*

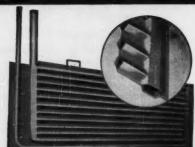
One of the finest technical laboratories in the country is the new Research Laboratory of Wyandotte Chemicals Corporation, Wyandotte, Michigan. A key feature of this laboratory is a series of 100-gallon plating and cleaning tanks made of various materials, such as rubber and plastic, which resist the actions of different types of chemicals. Individual tanks can be heated from room temperature to 212 degrees in less than an hour, by the Platecoil heat transfer units in the tanks. "We find Platecoil to be ideal because of their easy-to-clean surfaces and standardized performance," reports A. W. Liger, Supervisor of Industrial Research.





### **PLATECOILS** replace pipe coils for 50% of the cost

Coil-itis is the constant doctoring of wet processing tanks for pipe coil troubles. It can be cured easily by replacing pipe coils with Platecoils. Immediately, you will notice the difference as Platecoils put new life and profits into your heat transfer processes. They heat or cool 50% faster and take 50% less space in the tank. They save as much as 50% in mitial cost and 50% in maintenance costs in addition to overcoming the limitations and operating difficulties of old fashioned and outmoded pipe coils.



Bulletin P61 shows how Platecoils are replacing pipe coils at a savings throughout industry. Send today for your copy.



PLATECOIL TRANTER MANUFACTURING, inc., Lansing 4, Michigan

#### Depend on glass-lined GLASCOTE reactors

for long life in corrosive service

YOU'LL find the longer-lasting, corrosion-resistant reactor for your particular purposes at Glascote. The complete line of glass-on-steel models includes types for laboratory . . . for pilot plant . . . for production. Each design promotes improved performance in the specific application for which the reactor is built. Acid-Alkaline glass is yours at no extra cost. Whatever your job — whether it's blending, mixing or gas absorption — you'll find it pays to depend on Glascote reactors.

(In addition to glass-on-steel, Glascote also supplies stainless steel and other alloy equipment).

#### Plus these features for better service . . .



FREE FLOW assured, because all openings and piping provide uniformly smooth, wide surfaces. Cleaning is easy, too.



DEPENDABLE DRIVES transmit ample power for any processing requirement. Wide selection includes types to fit your particular needs.



STUFFING BOXES provide maximum performance with minimum maintenance. Extra-deep design.

VERSATILE AGITATORS incorporate threeblade design. Beaver-tail baffle attachment promotes widest variety of agitation patterns for all processing requirements.



ALL WELDED THERMAL JACKETING provides an extra-efficient method for handling heat or cold in processing. Jackets can be obtained for various pressures.

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CLEVELAND 17, OHIO

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### HOW TO BUY CONVEYOR BELTS

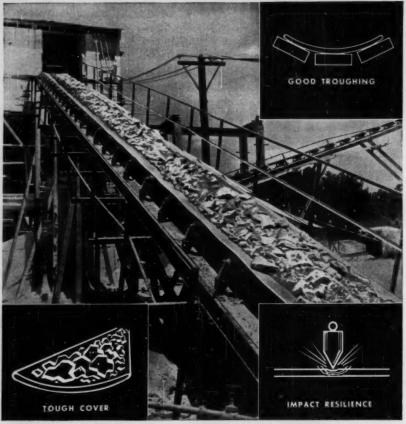
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Look for a belt with engineered features that assure maximum troughability, resistance to gouging, tearing or ripping, and dependable fastener-holding qualities.

Good troughing is the first thing to look for in an efficient, straight running conveyor belt on up and down grades. To trough properly, a belt must have full freedom and flexibility to make adequate contact with the center rollers. Conventional duck belting strong enough to handle the heaviest loads is stiff and "boardy", does not trough readily and consequently causes load spillage . . . especially where belts must follow uneven contours, as in mining operations.

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FLEXPIPE\* permits travel...absorbs vibration ...connects misaligned ports in pipe lines

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Flexpipe Connectors are designed for wet heating systems, and for trouble spots in commercial and industrial piping. Sizes, lengths, part numbers and operating pressures are given in the table below.

I.D.	Max. Offset each side of C/L (inter- mittent travel)	Over-all Longth Inches	Part Numbers	Max. Working Pressure at Room Temp. PSI	Max. Working Pressure at Max. Temp. (350°F) PSI
1/4	11/4	8 16	1/4 M-10 1/4 M-20	1200	850
3/8	1 1/4	9	3/6 M-10 3/6 M-20	1000	700
1/2	11/4	10	1/2 M-10 1/2 M-20	750	525
3/4	1 1/4	11 22	3/4 M-10 3/4 M-20	600	425
1	11/4	12 24	1 M-10 1 M-20	550	375
11/4	11/4	13 26	1¼ M-10 1¼ M-20	300	200
11/2	11/4	14 28	1½ M-10 1½ M-20	275	175
2	1/2	18	2 M-10	200	125

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#### S-A "Zipper" Conveyor-Elevator for Ammonium Chloride Ends Corrosion Troubles . . . .

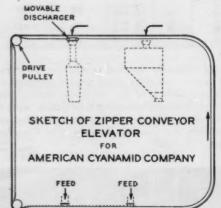
For a long time, handling of ammonium chloride had been a difficult and expensive operation for American Cyanamid Company at its Bound Brook, New Jersey plant.

Because ammonium chloride has a very corrosive effect upon ferrous metal, dust escaping during handling could cause serious damage. At the same time, ordinary enclosed conveying systems were similarly subject to corrosion troubles. An S-A "ZIP-PER" Conveyor-Elevator provided the economical answer.

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FIG. 2453 DG (Sectional)— 150-Pound Stainless Steel O. S. & Y. Gate Valve.

# Performance --- Walue ...



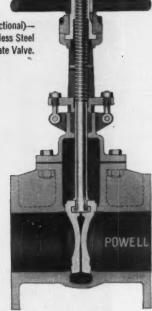


Fig. 1559—150-Pound Steel Lubricated Plug Valve.

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FIG. 2342—Stainless Steel Bolted Cap Swing Check Valve For 150 Pounds W.P.



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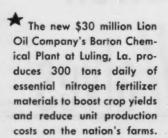
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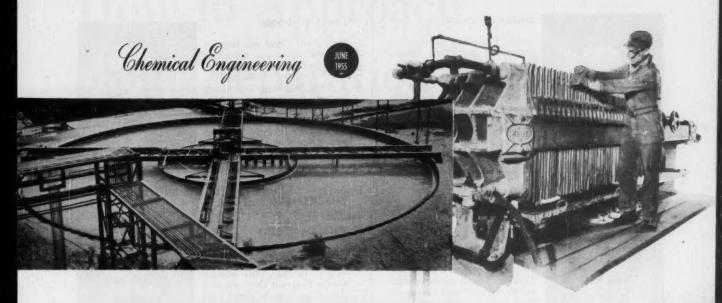






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HOW TO SOLVE YOUR PROBLEMS IN

## Solids-Liquid Separation

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ONCE again Chemical Engineering devotes the major part of its June issue to a critical and comprehensive survey of some technical aspect of the unit operations. Our subject this time, in 64 pages, is a symposium of six articles dealing extensively with the solids-liquid separations.

First topic of the symposium is the general problem of how to approach the separation problem so as to make an intelligent choice of the best method to use. Each of the five remaining articles then takes up one general class of solids-liquid separation equipment, discussing its theory, application, selection, and the types of equipment available. With each class of equipment it will be noted that the main function is to separate a solid more or less completely from a liquid. The function is not size or density separation of solids from solids, except incidentally, and sometimes with cyclones. This limitation is deliberate and its reason is that a separate report, in August, will deal with the solids-concentration operations such as classifying, jigging, tabling, froth and bubble flotation and dense-media separations.

CALVIN S. CRONAN ROBERT B. NORDEN THEODORE R. OLIVE

#### APPROACH TO SEPARATION PROBLEM. 177



#### JULIAN C. SMITH

Smith is professor of chemical engineering at Cornell, Ithaca, N. Y., where in 1941-2 he received his bachelor's and ChE degrees. Until his return to Ithaca in 1946, he was with Du Pont, in pilot plant and process evaluation work. Author of many articles, he is also active as a consulting engineer.

#### CENTRIFUGALS . . . 217

#### JAMES E. FLOOD

Since 1950 Flood has been in the unit operations consultant group in Du Pont's Engineering Service Division, at Wilmington. A 1941 chemical engineering graduate at Villanova, he gained plant operation and construction experience with Seagram's. After Navy service he joined Sharples for development of centrifugals.



#### WET SCREENS . . . 185



#### H. LESLIE BULLOCK

Consultant and professional engineer, Bullock and his company (Bullock-Smith Associates, New York) are process equipment specialists with extensive experience in screening, mixing, dust collection, and munitions plant safety. During the War he lectured on the latter subject at his alma mater, Columbia.

#### THICKENERS . . . 228

#### WILLIAM B. GERY

Gaining his BS at Penn State in 1918, Gery saw service in World War I. In 1925, after working for Du Pont and Dow, and two years of teaching, he joined Dorr in sales engineering and sales development. Since the Dorr-Oliver merger he has been in Stamford as director of the Industrial Technical Division.



#### **FILTERS . . . 191**



#### J. M. CHALMERS

Like the other authors of this paper, Chalmers is in the unit operations consultant group of Du Pont's Engineering Service Division, Wilmington. A 1924 BS in ME from Rutgers, he went into chemical plant design and construction, later into filter sales service and development. He joined Du Pont in 1942.

#### WET CYCLONES . . . 234



Head of minerals beneficiation research at Battelle Memorial Institute in Columbus, Tangel's professional life has been spent in mining and beneficiation. A 1932 Lafayette BS, he took his MS at Colorado School of Mines. He joined Battelle in 1941, but was an Army Ordnance captain during the War.



#### ROBERT J. BRISON

Minerals beneficiation research has engaged Brison's attention since he joined Battelle Memorial Institute at Columbus in 1947. Receiving his BS in metallurgical engineering in 1945 from Queen's College, Kingston, Ont., his first post-graduate activity was as field engineer with the Denver Equipment Co.



#### L. R. ELLEDGE



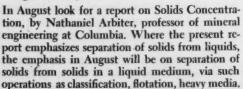
Much of Elledge's industrial experience since receiving his BS in ChE from Kansas in 1941 has been in heavy chemical processing and in solids-liquid separation. He joined Du Pont in 1951 and as a member of the Engineering Service Division is engaged in consultation for Du Pont's industrial departments.

#### H. F. PORTER



A 1934 graduate of University of Utah, Porter worked until 1950, when he joined Du Pont, for Wyandotte and American Potash. His experience in crystallizing, drying and solids-liquid separations led to his present position as supervisor of unit operations consultants in Du Pont's Engineering Service Division.

#### August Report . . .



## How to Approach Your Separation Problems

Solids-liquid separators are of many types, which makes selection a difficult problem in some cases. The best approach is a systematic one of eight main steps, leading to elimination of unsatisfactory types, and choice of one or more methods for further exploration.

#### Julian C. Smith

Choosing a solids-liquid separator is a lot more complicated than selecting most pieces of process equipment. By comparison, the choice of a pump or a compressor or a distillation tower seems simple and straight-forward. A multiplicity of separator types is on the market, many with overlapping functions; and to find the best one for your problem may be a long job. Usually it involves fairly extensive testing of one or more machines—but before that, you have to decide which types show enough promise to warrant extensive testing.

Later parts of this Report tell in detail about various types of solidsliquid separators, how they work and what they will do. Here we are not concerned with the final selection of a specific piece of equipment, but with the ways of approaching the problem. You must decide which types of separators are worth investigating, andequally important-which are not. A submarine works fine under water, but if you expect one to fly the chances are pretty good you will be disappointed. In the same way, some kinds of separators are not intended to solve your kind of problem. Eliminating those types which hold no promise at all can save a lot of time and waste motion, both by you and by the equipment manufacturer.

The steps in the approach are as follows: decide what you want to do; establish process conditions; take representative samples; make simple tests; stabilize the variables; and modify process conditions, where possible, to give the easiest separation. Then, make

tentative selections of the most promising types, and get in touch with the separator manufacturers. They will probably make additional tests of their specific machines, and then recommend a unit suited as nearly as possible to your needs.

#### Decide What You Want To Do

Deciding what you want to do may not be as easy as it sounds. It means much more than saying "I want to dewater 4 tons of fine solids per hour," or "I need to clarify 10 gpm. of viscous liquid." Yet separator manufacturers are often asked to quote on equipment with no more information than that. To select a separator intelligently you must have thorough and complete knowledge of the separation problem, the process variables, the properties of solid and liquid, and any restrictions or limitations on the operating conditions.

But even assembling all the details of the separation itself doesn't complete the job. In solids-liquid separations, more than in most operations, the performance of the equipment is strongly influenced by what goes before and what comes after. So it is essential to decide what you want to do over-all. Not "dewater 4 tons of solids per hour;" but go from this solution, in which the solids are dissolved, to this solid product-dried to 0.5% moisture, ground to 200 mesh, and containing no more than 0.1% of soluble impurities." The solidsliquid separation is only one step in the process. How it is done depends to a large extent on how the solids are precipitated or crystallized from solution, and at least to some extent on the way they are dried and ground after they are out of the liquid.

Sometimes, as when a new separator is proposed to replace an existing unit,

#### APPROACH YOUR SEPARATION PROBLEM IN EIGHT STEPS

- 1. Decide what you want to do
- 2. Esablish process conditions
- 3. Take representative samples
- 4. Make simple tests
- 5. Stabilize the variables
- 6. Modify process conditions, if necessary
- 7. Make tentative selections
- 8. Finally, consult the equipment makers

#### SOLIDS-LIQUID SEPARATION

the equipment preceding and following the separator is already on hand. The new separator must then meet existing conditions. Even here, however, don't ignore the possibilities of changing the other operations. In some problems the only way to an effective, economical separation is through major changes in other parts of the process.

#### **Establish Process Conditions**

After deciding what it is you want to do, you should pin down, as closely as possible, the characteristics of the materials you are separating and the quantities involved. Some of this information is easy to come by: you probably know how many tons of solids are involved and whether or not they must be washed. Other data are fixed by the nature of the final product—perhaps you are making a beverage that must be sparkling clear, or fragile crystals that must not be broken during the separation.

The accompanying tabulation lists the information needed for the selection of a solids-liquids separator, information a manufacturer would like to have on which to base his recommendation. It is the same information you need for making a preliminary selection. So fill it in as far as you can, and then estimate the remaining quantities or determine them by experiment.

Estimates of some items are nearly always necessary. In your approach to the problem, you may not have a fixed batch size, for example, or an operating cycle, or a well-established limit of the amount of solubles allowable in the product. You may not yet know how much solid you can afford to leave in the liquor, nor how much wash liquid is required. The rule is to make conservative—but not overconservative—estimates of quantities such as these, recognizing that they may be revised after you have made your tests.

Other questions must be answered by experiment. Experiments are necessarily made on samples; and in liquid-solid systems good samples are so important and so hard to get that the next section is devoted to them.

#### Obtain Representative Samples

Suppose you ask a process supervisor for a slurry sample on which to make separation tests. You are likely—if human nature is the same at your plant as elsewhere—to get one of two things: a sample of the best, most easily separated material the supervisor was able to find; or a sample of the worst. Neither one of them is "representative."

Of course, it's safer to design for the worst conditions rather than the best, but by considering only the worst you may overlook a separator that would be entirely satisfactory 99.9% of the time. So try to get a real picture of the slurry as it is from batch to batch, from hour to hour, from week to week. Take several samples, at intervals as

far apart as possible, under the most widely varying process conditions that you can. If your process operates batchwise, get samples made by many different operators. If continuous, take samples from all shifts. If your raw materials vary from time to time, be sure to find out how the slurry is affected by variations in the raw materials.

This sounds tedious, and it is, but the work can be minimized by sound planning. Statistical analysis of your test results can help a lot in setting up a sampling procedure. Careful work here really pays off in the long run; conversely, haste usually leads to trou-

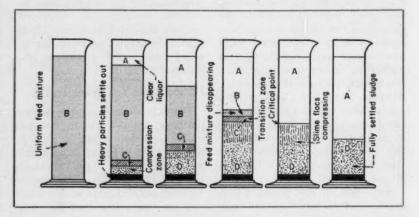
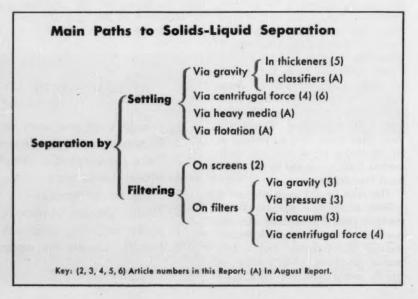


Fig. 1—Six phases of sedimentation as they occur in intermittent settling.<sup>1</sup> Flocculated pulps of fine light solids separate into four distinct zones, including clear liquor, pulp of feed consistency, a transition zone, and thickened pulp.



# I-Approach to Separation

ble. Above all, don't run a lot of experiments on a single slurry sample with nothing more than a fond hope that it is representative. It may be the most easily separated material the plant ever made, and the separator you recommend may never measure up to the results you obtained in your experiments.

But what if all you have is a 1-lb. sample of a new product, all that your laboratory has made to date? Almost certainly the laboratory sample won't be representative of the final plant product. Under these conditions your selection of a separator will have to be highly tentative. You can make

simple tests to find out what separators might work, and plan to make samples in your pilot plant for more extensive tests. Or you may rent or buy a small separator to include in your pilot plant.

Installation of the equipment in the actual process, in either a pilot plant or a full-scale plant, is the only sure way of obtaining representative samples. We'll have more to say about this kind of test later. Any such tests, of course, require that you first select the most promising types of separator—and it is this preliminary selection with which we are concerned at the moment.

#### Make Laboratory Tests

Once you have representative slurry samples, some simple laboratory tests will tell you a lot about their characteristics. These experiments fall into two classes, just as all solids-liquid separators—regardless of details—operate on one of two basic principles (not including the magnetic and electrostatic separators, which are not discussed here).

These principles are: (1) settling; and (2) filtration. The first class settles out the solids, by gravity or centrifugal force, or causes one solid to sink and another to float, as in flotation or heavy-media separations. In

# Data for Selecting a Solids-Liquid Separator

#### I. PROCESS

- A. Describe the process briefly. Make up a flow sheet showing places where liquid-solid separators are needed.
- B. What are the objections to the present process?
- C. Briefly, what results are expected of the separator?
- D. Is the process batch or continuous?
- F. List the available power and current characteristics.

### II. FEED

- A. Quantity of feed:
  - Continuous process: \_\_\_\_\_gpm.; \_\_\_hr./day; \_\_\_\_\_ lb./hr. of dry solids. Batch process: Vol. of batch:\_\_\_\_; total batch.\_\_ cycle: \_\_\_\_\_hr.
- B. Feed properties: Temp....., pH...., viscosity...
- C. What maximum feed temperature is allowable?
- D. Chemical analysis and specific gravity of carrying liquid.
   E. Chemical analysis and specific gravity of solids.
- F. Percentage of solids in feed slurry.
- G. Screen analysis of solids: Wet...... dry.....
- H. Chemical analysis and concentration of solubles in feed.

#### III. FILTRATION AND SETTLING RATES

- A. Filtration rate on Buechner funnel: \_\_\_\_\_gpm./sq.ft.
  of filter area under a vacuum of \_\_\_\_\_in. Hg. Time
  required to form a cake \_\_\_\_\_in. thick: \_\_\_\_\_sec.
- B. At what rate do the solids settle by gravity?
- C. What percentage of the total feed volume do the settled solids occupy after settling is complete? After how long?

#### IV. FEED PREPARATION

- A. If the feed tends to foam, can antifoaming agents be used? If so, what type?
- B. Can flocculating agents be used? If so, what agent?
- C. Can a filter aid be used?
- D. What are the process steps immediately preceding the separation? Can they be modified to make the separation
- E. Could another carrying liquid be used?

#### V. WASHING

- A. Is washing necessary?
- B. What are the chemical analysis and specific gravity of wash liquid?
- C. Purpose of wash liquid: To displace residual mother liquor; or to dissolve soluble material from the solids?
- D. Temperature of wash liquid.
- E. Quantity of wash allowable, in lb./lb. of solids.

#### VI. SEPARATED SOLIDS

- A. What percentage of solids is desired in the cake or thickened underflow?
- B. Is particle breakage important?
- C. Amount of residual solubles allowable in solids.
- D. What further processing will have to be carried out on the solids?

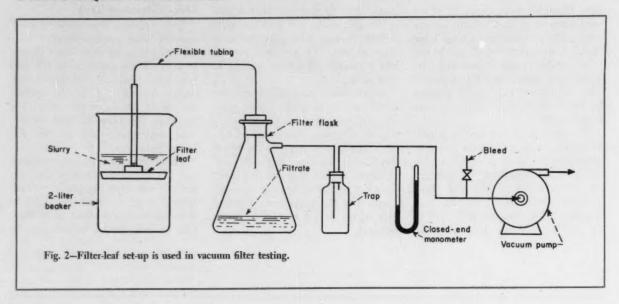
#### VII. SEPARATED LIQUIDS

- A. Clarity of liquor: what percentage of solids is permissible?
- B. Must the filtrate and spent wash liquid be kept separate?
- C. What further processing will be carried out on the filtrate and/or spent wash?

#### VIII. MATERIALS OF CONSTRUCTION

- A. What metals look most promising?
- B. What metals must not be used?
- C. What gasket and packing materials are suitable?

Author's Note: The form of this table is based rather closely on one used by the Merco Centrifugal Co.



the second class the liquid is forced through a permeable membrane or septum which retains the solids. In settling separators the individual solid particles sink (or rise) through the liquid; in filtering separators, except at the very start of the operation, liquid must flow through a compacted mass of solids.

Settling Tests-Gravity settling tests are made with a 1,000-ml. graduated cylinder, in which a well-stirred sample of slurry is poured and allowed to stand. Coarse, heavy, uniform solids rapidly settle to the bottom, leaving a clear supernatant liquid. Flocculated pulps of fine, light solids separate into four distinct zones, which are illustrated in Fig. 1 (from Perry's "Chemical Engineers Handbook," 3rd Ed., p. 938). Zone A is clear or nearly clear liquor; zone B is flocculated pulp of the same consistency as the feed; zone C is a transition zone; and zone D contains thickened pulp in which the floes rest directly one upon another. The relative proportions of these zones vary with time, also as indicated in Fig. 1. The sludge level, between zones A and B, is read at intervals and plotted against time, giving a graph which shows when hindered settling gives way to compression of the settled sludge. After settling is complete it is a good idea to investigate the firmness of the sludge by poking it gently with a glass rod.

Settling tests of this kind are discussed in detail by Anable<sup>3</sup> (also, a new simplified method on page 232 in this issue—Ed.). Pulps vary enormously in their settling characteristics, and interpretation of the test results is not always easy. At least, however, the tests should tell you whether or not gravity settling is feasible, and give an approximate idea of the settling area required and the maximum density of the settled sludge.

Let's suppose you want to thicken a dilute slurry of fine solids to give a perfectly clear liquor. If the solids in your sample settled in a few minutes to a dense, firm sludge that doesn't resuspend easily, and a supernatant liquor that is satisfactorily clear, chances are that gravity settling will do the job. If the supernatant liquor remains turbid for several hours, or if the settled solids are loose and easily resuspended, you probably won't be able to use gravity settling on the untreated slurry.

You then have three things to try: modifying the feed; centrifugal settling; and filtration.

Modifying the feed by changing the relative density of the solid and liquid, or by flocculating the solids, or by other means, often makes gravity settling feasible where otherwise it is not. We'll discuss this subject in a later section.

Centrifugal force greatly increases

the settling rate over that obtainable by gravity. In commercial centrifugals the developed force ranges from a few times gravity, in liquid cyclones, to about 13,000 times gravity in highspeed tubular centrifuges. You can make preliminary tests of centrifugal settling in a laboratory bottle centrifuge, using graduated tubes or bottles. Samples of slurry are spun for various times at various speeds, and the volume of settled solids, time required for complete settling, clarity of the supernatant liquor, and the density and firmness of the sludge noted as in the gravity settling tests. Ordinary bottle centrifuges generate a maximum of about 2,000 times gravity, so you may be able to do better in commercial equipment than you can in a bottle machine.

Still, tests will show you whether or not the application of centrifugal force is beneficial. Here again, modifying or pretreating the feed may greatly ease the separation.

If gravity settling and centrifugal settling both fail—or even if they succeed—you should make preliminary tests of the filterability of your solids. Although you may think that settling, or filtration, is best your approach to the problem should be to investigate both of them. Often they both work, and you should establish by detailed tests and economic comparisons, without prejudice, the best

choice for your particular set of conditions.

Filter Tests—Filtration is done industrially in four ways; under gravity, vacuum, pressure, or centrifugal force. Your tests should take this into account. Gravity filtration is usually restricted to wet screening and to the removal of traces of solids by percolating the feed through a porous filter bed. You can tell, almost by inspection of your sample or by draining the solids on a coarse screen, whether or not either of these methods is applicable to your problem.

Tests with a Buechner funnel will tell you a lot about the possibilities of vacuum filtration. As indicated in the selection table, you should measure the time required to form a cake of a given thickness, and the volume of filtrate collected in doing so. See how fast wash liquid can be sucked through the cake. Find out how dry the solids can be made by drawing air through them, and note any tendency of the cake to crack during "drying." If you have to filter more than very small amounts of solids, you should use canvas or woven metal cloth as the filter medium, rather than filter paper.

If a continuous vacuum filter looks as if it might be the answer, you may want to make additional tests on a filter leaf, as shown in Fig. 2. You can make your own leaf, or obtain one at small cost from filter manufacturers. It consists of a disk of metal or plastic, about 4 in. in diameter, with a corrugated face over which a circle of cloth is held by a metal band. A discharge pipe, threaded into a central hole in the disk, leads through rubber tubing to a vacuum filter flask, which in turn is connected to an ejector or vacuum pump.

The slurry sample is placed in a 2-liter beaker, and the vacuum turned on. The leaf is submerged in the slurry, face down, and moved gently up and down to keep the solids in suspension. Filtrate collects in the filter flask. The time required to form a reasonably thick cake—say ½ to ½ in. thick—under a given vacuum is noted, as is the volume of the collected filtrate. The leaf is then removed from the slurry and slowly turned face up. As air is drawn through the cake it may crack, or even fall off the leaf.

Such uncooperative tendencies should be recorded. If washing is required the leaf and cake are submerged in a separate beaker of wash liquid and the time required to suck through a measured volume of wash is determined. The cake is "dried" once more by drawing air through it. The vacuum is then turned off and the cake removed from the leaf by a spatula or by blowing gently into the filtrate pipe. The cake is weighed, sampled, and analyzed for moisture and for soluble impurities.

This procedure simulates the action of a bottom-fed rotary vacuum filter, and when properly done-by an expert-may give enough information for the complete specification of a plant-size filter. Probably you won't have as much confidence in your results as this requires, but the tests will certainly show you whether or not a vacuum filter is worth testing, and give some knowledge of the size of the filter needed. In estimating filter size remember that only part of the total filter area is submerged in the slurry at any one time, and that the total area required must be several times that predicted for the filtration cycle alone.

The apparatus shown in Fig. 2 can also be used, of course, in preliminary tests of vacuum filter thickening.

Pressure filtration is necessary where the liquid is very viscous or highly volatile, or where the solids are so fine that vacuum filtration is too slow. Cartridge filters and edge filters usually operate under pressure, as do most types of filter presses. Tests with a small plate-and-frame press, using different applied pressures, will show if pressure filtration has promise for your job. In some situations you can extrapolate from vacuum filter tests to pressure filtration, although if high

pressures are needed (say 100 psi. or more) vacuum filtration tests won't tell you much.

In pressure filtrations of slow-filtering solids don't overlook the possibilities of precoating. Filtration rates can be vastly increased by this technique, which is discussed in the section headed "Modify the Feed."

If the solids are fairly easy to filter, and a low moisture content in the filtered solids especially desirable, you should consider centrifugal filtration. Tests can be made in a laboratory centrifugal with a perforated basket 10 or 12 in, in diameter, and lined with canvas or other cloth medium. Slurry is poured into the rotating basket until a cake about 1 in. thick is formed. Then filtrate is recycled to the basket at such a rate that a thin layer of liquid is just visible on the surface of the cake. The discharge rate of the liquor under these conditions is the "draining rate" of the solids. It is not always easy to measure the draining rate, especially if the solids drain very quickly or very slowly, but you can usually make a fairly good estimate of it. Once the draining rate is determined the cake is spun until no more liquor comes off, and the "spinning time" is measured. The basket is stopped and the cake is removed, weighed, sampled, and analyzed. Its thickness is also measured. Similar tests at various basket speeds and cake thicknesses are then made, together with washing tests where washing is required. The data so obtained will permit you to estimate the size of a centrifugal to do the job. A detailed discussion of this type of test and its interpretation is given in the literature.8

One thing to remember in considering centrifugal filtration is that most centrifugal filters are unloaded by a

"Choosing a solids-liquid separator is a lot more complicated than selecting most pieces of process equipment. . . . Here we are not concerned with the final selection of a specific piece of equipment, but with the ways of approaching the problem. You must decide which types of separator are worth investigating, and—equally important—which are not. . . Some types of separator are not intended to solve your problem. Eliminating those types which hold no promise at all can save a lot of time and waste motion."

knife or scraper conveyor, which may do a lot of damage to the particles. Reciprocating conveyor centrifugals give less crystal degradation than other types, but when the crystals are very fragile or when almost no degradation is permissible, a vacuum or pressure filter may be the only answer.

#### Stabilize the Variables

In testing several different slurry samples you have probably found out the factors that favor easy separations. It may require some detective work, but often you can relate the settling rate or filterability of a slurry to the conditions under which it was made. Perhaps a slow rate of cooling or a high temperature in your precipitation tank gives a fast-filtering solid; perhaps that bad batch you found contained an impurity that occasionally gets into the process, but which could be kept out with a little more care. In any event it is hard to design a separator for widely varying conditions, and you should make every effort to stabilize the variables. The more closely you can standardize process conditions the more successful your installation is likely to be.

Stabilizing the variables may involve more careful operation of the process, and perhaps closer supervision of the operators' technique; it may require tighter specifications on raw materials; it may mean additional automatic controls. Continuous processes are especially amenable to automatic control, but modern controllers are also adaptable to batch and intermittent cyclic operations. On a batch crystallizer, for example, a cyclic temperature controller, giving exactly the same pattern of temperature change from batch to batch, may result in much more reproducible slurries than any group of operators. In addition, positive control of the cycle makes it easier to study the influence of process variables, and to find the conditions that give easiest separation.

#### Modify the Feed

In some troublesome separations stabilizing the process variables changes the feed slurry enough to solve the problem. In others it does not. More drastic modifications of the feed are then in order. Things to consider include flocculating agents, ultrasonics, filter aids, changing the relative densities of solid and liquid, and using a different carrying liquid. One other possible change, even more radical than these, is suggested later.

Colloidal and near-colloidal particles either won't settle at all or do so at prohibitively slow rates. When filtered they usually form a dense impermeable cake. If, however, the small individual particles can be coalesced into larger flocs or aggregates they will settle much faster and often form a fairly porous filter cake. Flocculation is accomplished by changing or destroying the ionic cloud surrounding the very fine particles, or by adsorbing material on the surfaces to form bridges between particles. Only small amount of flocculants are needed. For example, if in a bottle centrifuge the supernatant liquid remains hazy after a long spinning time, try adding a drop or two of a solution of aluminum sulfate or trisodium phosphate to the next sample before centrifuging. Often the haze will quickly disappear. Synthetic polyelectrolytes, known commercially under a variety of names, are even more effective. These agents are believed to act by adsorption (by ester formation or hydrogen bonding) of hydroxyl or amide groups on the solid surfaces, each polymer chain adsorbing on and bridging between more than one solid particle.3

Once in a while you want to go the other way-that is, to keep the solids from coalescing. In washing a precipitate by repulping it in wash liquid, for example, it is important to avoid flocculation. This is also true when coarse particles are to be settled out of a suspension of very fine solids, where flocculation would lead to contamination of the settled material. Commercial dispersing agents induce charges on the solid particles, keeping them from coalescing. Some agents not only keep fine solids in suspension, but in very small amounts can transform a thick sludge into a free-flowing, pumpable semiliquid with no change in solids content.

The application of ultrasonics to a troublesome slurry may greatly change its properties for the better. In many types of system it causes coagulation and increased settling rates. This is a new technique that has received rela-

tively little study, but which may well bear investigation.

Sometimes you have to filter a slimy or gelatinous material, which even in the presence of a flocculating agent forms a highly impermeable cake. Filtration may virtually stop after no more than a thin layer of solids has been deposited. In this situation you should consider a continuous precoat filter, on which a layer of filter aid is deposited before the filtration itself is begun. During filtration an advancing doctor knife peels the deposited solids and a thin layer of filter aid off the filter drum, exposing a fresh porous surface to the slurry. Eventually, of course, the operation must be interrupted and a new layer of filter aid deposited on the drum, but this may be necessary only once a day or so. Continuous precoat filters may now be operated under considerable positive pressure, as well as under vacuum.

In problems involving settling you may find it desirable to change the relative densities of solid and liquid. This can be done, sometimes, by heating the slurry to reduce the density (and simultaneously the viscosity) of the liquid. Some solids settle much more rapidly hot than cold. Another way is to absorb air preferentially on the solids in a flotation cell, using a suitable flotation agent, to make some or all of the solids rise to the liquid surface. Still another way, also used most where one solid is to be separated from another, is to make a dense pseudo-liquid consisting of a suspension of very fine particles of heavy minerals like magnetite, ferrosilicon, or galena. Liquid media of this kind are used in "sink-and-float" processes for ore treatment. In your situation it may be easier to get the solids to rise to the liquid surface than to persuade them to sink to the bottom.

You may also change the liquid by adding or substituting another chemical compound. Common salt and calcium chloride are often dissolved in water to form dense brines; alcohols are sometimes used to reduce specific gravity. Heavy-fluid separations employ chlorinated hydrocarbons as the liquid medium, avoiding water entirely. Perhaps a nonaqueous liquid would be the answer to your problem. Nonaqueous suspensions will probably find increasing applications

in the future, for particles which barely settle in water often sink like a stone in liquid ammonia or sulfur dioxide or other liquids. Their use involves additional processing problems as well as the expense of recovery, but in difficult separations the over-all economic picture may favor them strongly. Water is the commonest liquid, but don't forget that others exist and sometimes may be worth considering.

Finally, there is the possibility (though the suggestion may seem like heresy in this Report) that you don't want a solids-liquid separator at all. It goes back to your over-all objective. For example, you may want to go from a solution of your solids to a finely divided dry product. Sometimes this can be done in a single step, bypassing the crystallizer, separator, dryer, and grinding mill, and greatly simplifying the process. A drum dryer, for instance, will take a feed slurry and yield a dry, flaky solid product in one operation. A spray dryer can handle either a solution or a slurry, turning out dried solids that may be of just the right particle size. Washing is not possible in these devices, but perhaps you can modify the feed so that washing is not required. In any event, they illustrate the possibilities of solving a separation problem by an indirect approach, going around it with a flanking movement instead of overcoming it by direct attack.

#### Make Tentative Selections

After you have filled out the selection table and read the other articles in this Report, you will probably have a pretty good idea of the best types of separator for your problem. You will know whether you want classification, or thickening, or virtually complete separation, and whether settling or filtration is the more promising approach.

Sometimes the choice is obvious. If you want to separate a dense coarse solid from a lighter solid, a heavy-fluid separation may be clearly indicated. If you can preferentially adsorb air on one solid and not the other in the presence of a suitable agent, flotation may be the answer. If free-draining coarse particles are to be separated from finer ones, or from a liquid, or both, wet screening holds promise.

"Deciding what you want to do may not be as easy as it sounds. To select a separator intelligently you must have thorough and complete knowledge of the separation problem, the process variables, the properties of solid and liquid, and any restrictions or limitations on the operating conditions. . . . More than in most operations, the performance of the equipment is strongly influenced by what goes before, and what comes after."

Gravity settling classifiers, including drum classifiers and rake classifiers, are also worth investigating. With finer solids, down to particles a few microns in diameter, classification is best done in continuous helical-conveyor solidbowl centrifugals.

If thickening is your problem the choice is less clearcut. You can use either settling or filtration. Gravity settling in large mildly agitated thickeners is favored when very large amounts of dilute liquid are to be handled. More concentrated feeds may be economically thickened (often to very dense sludges) in helical-conveyor centrifugals. This operation might be more properly considered as solids dewatering, rather than thickening, although there is really no clear distinction between them. Thickening is usually considered to be an operation yielding a pumpable underflow; dewatering gives a non-pumpable sludge or crystalline mass.

Thickening may also be done by filtration, either under vacuum or under pressure. Filter-thickeners handle relatively small quantities of feed, but are completely enclosed and give a solids-free liquid, while the overflow from the settling machines usually contains some suspended solids. Also, filter-thickeners can handle some slurries that cannot be thickened by settling at all, either by gravity or centrifugal force.

The foregoing operations—heavy-fluid separations, flotation, and thick-ening—are almost always continuous. If your problem involves the nearly complete separation of solids from liquids, especially if the solids are to be washed, you have a choice of batch or continuous methods. To complicate matters further, some machines are continuous with respect to one phase, usually the liquid, and intermittent with respect to the other. Still

others are completely cyclic, but operate on such short cycles that they are readily incorporated in continuous processes.

As a rough rule, batch separations are used when the quantities handled are very small; when many different materials must be handled in the same piece of equipment; or when some part of the operation, such as washing, requires a very long time. Continuous processing is favored when production rates are high and all parts of the operation are rapid and easy. Continuous separators usually—though not always—handle only a single product, and are less flexible than batch separators.

Continuous-intermittent separations occur most in clarification or "polishing" operations, in which small amounts of solids are removed from large volumes of liquid. Traces of dirt are removed from rayon viscose, for example, in high-pressure filter presses that need be unloaded only once a week. Oversize particles are thrown out of dye suspensions by high-speed tubular centrifuges. Each centrifuge bowl can hold only about 10 lb. of sedimented solid before discharging becomes necessary, but so little solid is removed that the bowls need to be cleaned only about once a day.

When more than traces (say more than 1% or so) of solids are present in the liquid it pays to investigate machines which discharge solids continuously, unless your production rates are very small. Continuous rotary filters and high-speed centrifuges with nozzle discharge or valve discharge for the solids may well prove economical. With concentrated slurries continuous solid-bowl conveyor centrifugals and—for free-draining solids—screen conveyor and batch automatic centrifugals come into the picture. So do top-feed and horizontal rotary vacuum filters.

If you have a heavy slurry that must be separated batchwise you should consider filter presses and batch centrifugals.

Sometimes you know for sure that the separation must be batchwise; sometimes the slurry is so easily separated and so large in volume that continuous separations are strongly favored. In other situations, however, both batch equipment and continuous equipment will work, and you must choose between them. There is no clearcut answer in such cases. Broadly speaking, if you are dewatering less than 300 lb./hr. of solids, continuous filters and centrifugals probably are not economical; if you are handling more than 1,000 to 2,000 lb./hr., continuous separation is probably worthwhile. Problems of this kind can be resolved only by detailed economic compari-

Another choice you may have to make is among continuous filters, settling centrifugals, and filtering centrifugals. Often all three will work, and may cost about the same for a given production rate. Your choice must be based on specific characteristics of each type, such as floor space and foundations required, maintenance costs, power, and operating attention. Remember, too, that filters usually give a cleaner effluent liquor than do settling devices, and even than continuous filtering centrifugals. The filter medium in a continuous centrifugal is a slotted metal plate or a wire screen, so coarse that some fine solids nearly always appear in the filtrate. On the other hand, centrifuges and centrifugals produce drier solids than any filter.

Typically, if the cake from a vacuum filter contains 7% liquid, the same solids when centrifuged might contain 3%; if the filter cake is 30% liquid, centrifuged material might be 20% liquid. When solids are to be thermally dried after separation this reduction in moisture content may argue strongly in favor of centrifuging. On occasion it will even justify a batch centrifugal, despite added operating attention, over a continuous vacuum filter.

#### Consult the Manufacturers

Now is the time to get in touch with the separator manufacturers.

#### Parable of the Inquiring Consultant and the Reluctant Client

In the early days of a highly confidential process, a consultant was called in to design a special reactor. "What are you processing?" he asked. "Good grief, man, we can't tell you that!" was the horrified reply. "Well, what are the temperatures and pressures?" "M-m-m-we'd better not say." "Then, how about materials of construction—what metals can be used?" "Sorry, that's secret information!" "Fine, fine-it's been a pleasant trip gentlemen. You'll get my bill shortly," said the consultant as he reached for his hat.

Once appraised of your interest, they will probably send you a form much like the selection table, asking for the details of the problem. And your reaction may be that they want to know entirely too much about your process, when all they are asked to do is quote on a separator. (But first read the "Parable" above before you decide too definitely-Ed.)

When you go to the manufacturer, give him as much information as possible, and the complete story if you can. Reputable manufacturers don't try to nose into your business, and will never violate your confidences. Sometimes, of course, you have to withhold information; but when you do you should expect to pay for it. The separator you install will probably be less economical, less satisfactory, and much more trouble to get started than if you had cooperated fully with the manufacturer.

The separator manufacturer will probably want to make laboratory and pilot-plant tests of his specific equipment, and will request samples. In supplying them you should follow the same procedure as in your initial tests, making sure that the samples you send are representative. If for pilot-plant tests they should be large enough to give the separator a thorough trial. Many machines work fine at first, but can't keep up their good work for more than 15 or 20 min.

The most fool-proof test method is to rent or borrow a machine from the manufacturer, install it in your plant or semiworks, and run it for a month or so. Such a test can be expensive, even if the machine is fur-

nished rent-free, and should only be undertaken if preliminary tests indicate the machine has a lot of promise. On the other hand, it will demonstrate operation on truly representative material; show up long-term operating problems; and give you operating experience that will be valuable if you later install your own separator of this kind. Such a plant trial will alsoif you wish-avoid divulging process data to the manufacturer. Even here, however, it is wise to tell the manufacturer what you are doing, in order to draw on his extensive store of experience. What seems baffling to vou may be an old story to him, and a few suggestions on his part may spell the difference between success and failure.

So in tackling your next separation problem the approach is this: Read the articles which follow. Decide what you want to do. Establish the process conditions. Obtain representative samples. Make simple laboratory tests. Stabilize the variables. Modify the feed, if necessary. Make your tentative selections of the most promising separators. And finally-consult the manufacturers. Tell them as much as you can, so that they can help you specify the separator which is most likely to solve your particular separation problem.

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# Wet Screens

H. Leslie Bullock

Wet screens occupy a position somewhere between settling tanks and filters. In suitable applications they can handle large tonnages continuously, with minimum floor space, cost and power.

Wet screening provides an efficient method of operation for handling large tonnages continuously in equipment which requires a minimum of floor space and horsepower. If properly designed and selected, such equipment has low maintenance costs. In some applications it allows great savings in labor compared to earlier hand methods. Wet screening ahead of filter presses or centrifugals results in much longer runs for the final separators between cleanups.

Spray washing on wet screens leads to continuous production and is not subject to dead spots or short circuits as in tank washing. By using screens with sectional decks-or screens in series-mother liquor can be removed and the retained solids spray washed under conditions of great uniformity. In handling ores, sand and gravel and coal, wet screening avoids the usual dust nuisance and permits the washing away of clay deposits which may cement small particles to larger ones, form aggregates or contaminate the product. Tests are easily conducted at low cost and are well worth the trouble as new separation problems develop.

In the early days of wet screening stationary screens were first used, and later rotating trommel screens. Later, more elaborate vibrating deck screens were developed, using (1) electric vibrators, (2) offset weights, (3) balanced cranks, and (4) positive eccentrics to produce the motions found most desirable for screening.

#### Screen Actuators

Electric vibrators produce a quickreversing, linear motion which is usually applied perpendicular to the screen surface. The most generally used frequency is from 1,800 to 7,200 per min., which gives a rapid motion to the screen surface. The amplitude is comparatively low and does not produce violent agitation of the mass.

Rotating offset weights are used in several ways to produce vibrating motion in a screen deck. The commonest arrangement supports the weights on a horizontal shaft carried rigidly on the screen deck structure. In the arrangement of Fig. 1 opposed offset weights cause reciprocating motion of the horizontal deck at an angle of 45° to the deck surface. In the more usual type of Fig. 2 the single horizontal shaft extends across the deck at its midpoint, either above or below it. In any event, the deck structure is supported near its four corners on springs, rubber buffers or cables which allow free motion of the structure when the offset weights are rotating.

Offset weights operate on a relative inertia basis so that a variable load on the screen deck will alter the amplitude of vibration. The offset weights move the entire screen deck structure and each point of the deck has a closed path of motion in a vertical plane. The theoretical path in Fig. 1 is a straight line, and in Fig. 2 a circle, but the actual shape of the path of motion may vary with the method used to suspend the screen deck, and the relative position of the centers of gravity of the deck structure and of the offset weight unit. Heavy moving loads on the screen deck change the location of the center of gravity of the deck structure, with the result that the motion is also changed.

In another method of using offset weights, the shaft is vertical and the deck structure is either suspended by a flexible mounting or supported on slender rods, or on spring members, as in Fig. 3. The mounting is kept as free as possible for movement in a horizontal plane. Rotating the offset weights then produces a radial or circular motion of each point of the structure in a horizontal plane. In the type shown in Fig. 3 a second, tipping motion is added by the use of a second weight below the motor. With the center of gravity of the

vibrating structure at the upper weight, the effect of setting the lower weight at various angles to the upper is to alter the amounts of radial and tipping action and thus allow adjustment of screen action to fit various materials.

The vertical-shaft, offset weight screen originated in the old foundry riddles which used a U-frame suspended by a flexible connection from the ceiling. The motor was mounted near the point of suspension, with a vertical shaft extending downward to the offset-weight unit. The latter was mounted near the center of the screening surface. The original rather crude type has been developed to include base-mounted, multiple-deck units arranged for continuous production.

In some early screens, balanced crank assemblies were used to raise and drop one end of a hinged deck structure. Few screens of this type are now in operation and the use of balanced cranks is now restricted to gyratory screens where the crank rotates in a horizontal plane. Such screens, as diagrammed in Fig. 4, are connected to the rotating crank at the upper end of the screen structure while the lower end is supported on parallel slides or by linkages which restrict the movement of the screen structure to a longitudinal motion parallel to the main axis of the screen deck. The motion of each point of the deck structure is substantially in a horizontal plane and varies from almost a true circle near the crank, through irregular elliptical motion, to practically straight line motion at the lower end. Average strokes are from 2 to 3½ in. With this arrangement speeds of rotation are necessarily low, ranging from 200 to 325 rpm.

The positive-eccentric type of vibrator indicated in Fig. 5 produces a uniform motion in the screen deck structure which is not influenced by loading. As the eccentrics are readily made adjustable, screens of this type can be furnished for variable stroke

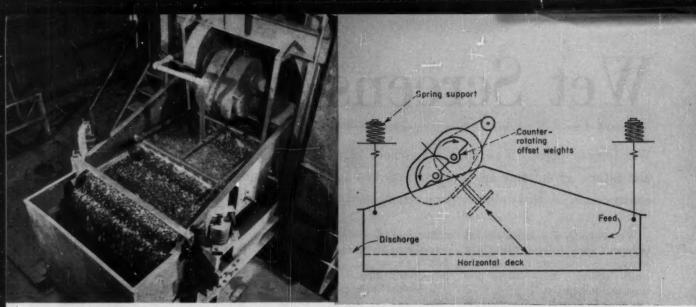


Fig. 1-Low-Head screen uses opposed offset weights, here washes tailings, recovers heavy media in iron-ore plant. (Allis-Chalmers)

adjustment which permits close tuning to various operating conditions. The shaft which turns the positive eccentrics is mounted horizontally across the center of the screen. When the unit has come up to speed, the motion of every point in the deck structure is theoretically a true circle in a vertical plane. Actually, there may be some damping from the suspension members and the motion may be slightly elliptical at the screen body ends.

Screens with electric vibrators and those of the gyratory type work best on suspensions of low solids content where violent vertical motion is unnecessary to compact the solids and expel additional liquid. Gyratory screens have found wide application in scalping fibrous material from starch as the gyratory motion tends to ball up the foreign material. At the same time, there is no tendency to upend the fibers and allow them to work through the fine mesh.

Offset-weight and positive-eccentric screens both have motion in the vertical plane which tends to compress the solids and to shake liquid from the oversize material. Much of the material dewatered by wet screening is of a fibrous nature and a wet, fibrous load on a screen tends to move as a single mass or mat. Therefore, a combination shaking and compressing action is very important in accomplishing efficient dewatering.

#### Screen Application

Wet screening, as now developed in the chemical, food and mineral concentration fields, is a valuable method both for the size separation of solids in slurry form, and for the separation of solids from liquids. It must be understood that wet screening cannot give complete separation of liquids from solids. This is because there is no appreciable pressure which will squeeze moisture from fibrous material or remove thin films of moisture held by surface adhesion or capillary attraction.

In liquid separation, the field for wet screening lies between that of the sludge settling tank and squeeze rolls or filter presses. In fact, wet screening is often used as a preliminary step to squeezing and filtering. The amount of moisture left in the solids depends on the surface structure and the porosity and size of the particles. Smooth, closely grained gravel or coal above 5 mesh can be screened to a moisture content of from 3 to 10%, while fibrous vegetable refuse from a food packing plant will hold from 85 to 100% moisture.

Wet screening is being extensively substituted for sludge settling tanks, primarily because of its quick, continuous action and economy of space.

Wet screening for solids removal has its greatest field of application in the size range up to 40 mesh, where screens of from 50 to 55% open area can be used. In these the wires are still of sufficient diameter to produce a strong structure. As the mesh number increases and the size of the holes decreases, the wires have to be of relatively larger diameter, with the result that the open area decreases and the

dewatering capacity is cut down. Even with this slight relative increase in wire diameter, the finer mesh cloths are rather weak and are prone to tear if not supported firmly in all directions. Meshes smaller than 40 usually require reinforcing, either with a backing of heavier, larger-mesh wire cloth, or with perforated metal, as in Fig. 5. These reinforcing constructions further decrease the open area and reduce the capacity.

Solvent and water separations from fibrous material can be efficiently handled on screens as fine as 120 mesh. Clay slips are scalped free of foreign and oversize material at 120 mesh, and milk of lime and calcium carbonate suspensions are scalped through 200 mesh in our paper mills.

From these examples, it will be seen that the finer-mesh wet screen has its best application where a suspension of uniformly fine particles is being passed through the screen to remove oversize or foreign material. If the fine material—clays, pigments and fillers, for example—must be retained by the separating surface and dewatered, we find this a job for a filter.

A wet screen must have a mesh opening large enough to allow water to shake through it in spite of surface tension and the capillary attraction between the crossed wire surfaces. Mesh openings of this required size are too large to hold back fine pigments and clays. Since screening is a continuous operation, any oversize material which would collect cannot be allowed to remain and form its own filter bed, as happens in a filter press. Instead,

it must be continuously discharged as oversize. The commercial limit on wet screening therefore seems to be scalping at about 200 mesh.

## Operating Variables

Operating variables are very important in any wet screening application. The various types of screens differ in their adjustability, but all of them can

Offset weight on

horizontal shaft

be modified in some manner to suit any particular type of operation. The main variables include: deck slope, vibration amplitude, operating speed, and feed rate.

1. Adjustment of Slope — Efficient separation and dewatering is a direct function of the time taken for the material to pass over the screen deck. This time is directly affected by the slope of the deck. A steep downhill

Motion usually

elliptical

Spring support

slope provides rapid flow. Decreasing the slope increases the time until the point is reached where the slope is uphill and the motion of the screen deck must convey the material over the screen surface. Where the flow is produced by the screen motion, it can, of course, be cut down by using a steeper uphill angle. This provides a very sensitive adjustment for getting the maximum degree of dryness. Uphill operation usually is limited to slopes of from ½ to 5°.

2. Amplitude of Vibration—The amplitude of vibration affects both the speed of travel across the screen and the dryness of the final product. The speed across the screen is increased with increase in the amplitude of motion, provided the motion is fast enough to produce a throw of the material and is in the right direction. Greater water removal results if the speed is such that a beating action is obtained on the under-side of the moving blanket of collected solids.

3. Speed of Operation — Speed is critical in most operations in regulating the rate of passage of the material over the deck, and in beating the liquid efficiently from the solids. Mechanical vibrator speeds of from 900 to 1,750 rpm. are regularly used in the U.S., and speeds up to 3,600 rpm. have been reported from England.

4. Feed Regulation-When a wet screen has been adjusted to produce the desired separation and maximum dryness of the collected solids, it is, of course, desirable that it be operated at the maximum capacity. The actual tuning of the screen is usually done with a cut-down feed. Then the feed valve or gate is opened to a point just below that at which flooding of the screen surface appears. On screens operating uphill, it is easy to see the point where the flooding of the surface stops. With screens operating downhill, judgment of the correct feed rate must be made by examining the collected solids for water content.

## Screening Surfaces

A great variety of screening surfaces is available for wet screening, including woven plastics, woven wire, rod

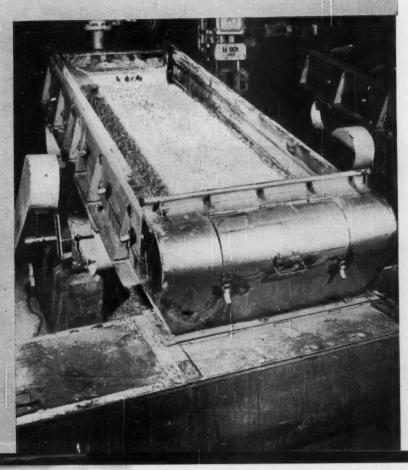


Fig. 2—Offset-weight vibrating screen of stainless steel separates starch slurry from coarse fractions in corn milling. (Link-Belt)

screens of the Wedge-Bar and B-Z types, and perforated metal. The screen material should be strong, with a minimum of stretch on insertion, as well as corrosion and abrasion resistant. The percentage of open area is very important, since capacity varies directly with this figure. In square-weave cloths, open areas of from 45 to 55% produce good results. At the same time, the cloth is sturdy in all meshes up to 100, even with this large percentage of open area.

In all woven materials, the strands and the weave should be smooth to reduce the tendency of solid material to stick and build up, thus producing blinding. Special weaves, such as elongated slot wire, are available for some troublesome materials. Woven wire screens finer than 100 mesh and of a reasonable percentage of open area—say, above 37%—must be made of extremely fine wire so that they are really very delicate. Such screens must be supported either on coarser wire mesh, perforated metal or bar screens.

#### Types of Wet Screen Use

Many industries use wet screening for different purposes at various points in their plants. Therefore, a division of screen applications on the basis of desired results will probably give a better picture than a division according to industries. It must be understood that there is no clear-cut line between the various applications of wet screening, since one application will blend into another in actual plant practice.

Her ever, such a division on the basis of assired results may be made under five categories, as follows:

(1) Screening for solids sizing, as in the wet screening of sand and gravel, ores and coal; (2) screening for solids scalping, as in the starch industry, where fibrous material is removed from the wet slurry on relatively coarse mesh; (3) screening to obtain the cleanest solid product, as in the manufacture of TNT, synthetic rubber and starch; (4) screening for the maximum recovery of solids and the greatest clarity of liquid, as in the papermill screening of white water, the screening of fish and vegetable oils, and of plant waste; and (5) screening to obtain the maximum recovery of liquid product, as in the separation of liquid extracts in pharmaceuticals.

The fourth and fifth categories above may appear very similar until we realize that in screening to remove maximum solids and produce a clear liquid, we must not use a violent screen action which might break down solids aggregates so that small particles could go through the mesh. However, in screening for maximum recovery of liquid product, a violent action must be used and the valuable liquid subsequently filtered or centrifuged to remove fine solid particles.

#### Wet Screen Construction

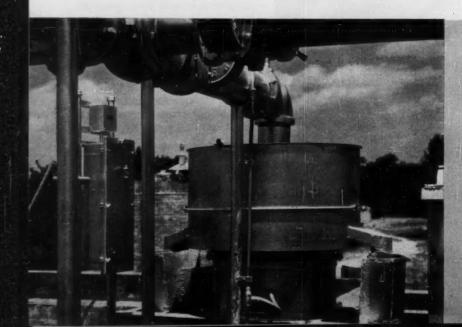
In general, screens which operate with a downhill slope do not deliver as dry a solids product as those operating uphill. This comes from (1) the tendency of the separated liquid to flow down the wires and strike through from the back of the screen, and (2) from the rapid flow of liquid down the front of the screen before it has time to flow through the mat of solids.

Screens supplied with hot, wet material, from which a portion of the water may flash into steam within the screen compartment, should be vented so that there can be no generation of pressure under the screen deck to interfere with the flow of the liquid through the mesh. Enclosed units should never discharge into unvented pipe lines or tanks where positive pressures may be built up, since this will tend to decrease or stop the flow. Suction in the discharge lines should also be avoided, as this will sometimes cause the oversize solids to stick to the upper surface of the screen until complete blinding results.

Efficient uphill-conveying screens will deliver many sorts of solids to the upper end of the screen deck so dry that they will not flow freely from the unit. This requires use of a short, smooth lip discharge extending across the full width of the screen deck to avoid stoppage of the flow.

#### Screen Cost Estimating

Required size of screens and their approximate cost is best estimated after running actual tests on the material to find screen area that will be needed. However, this can be fairly closely estimated from screening data



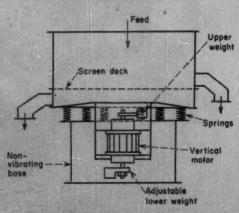
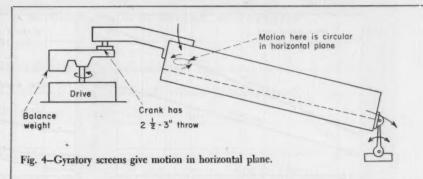


Fig. 3—Vertical-shaft offset-weight screen removes fibrous solids from 400 gpm. of waste water for discharge to sewers. (Southwestern Eng. Corp.)

on similar materials, or from records of other mesh separations on the same material. Table I gives rough screen capacity on a considerable range of wet materials. If plant-scale screening rates must be estimated without tests, then a careful screen analysis of the material should be made to determine how much material will go through each screen, and how much near-size material is present to slow down screening rates.

To estimate screen cost after finding the screen area needed, we first determine the bare-screen cost range for a single-deck screen of required area, then add a suitable percentage for various refinements if needed. From the screen type and kind of service we find whether the duty is light, medium or heavy, and from that, find the motor horsepower needed. The cost of the fabricated screen decks is then estimated from the kind, mesh, and area of screen required. Total screen cost is then the sum of the bare screen cost, plus refinements, motor drive, and screen wire decks.

To determine the bare-screen cost range we use Fig. 6a on which the minimum-cost curve applies to the simplest single-deck screen of open construction, while the maximum-cost curve applies to a single-deck screen of open construction provided with adjustable slope and stroke, demountable screen decks, and all-metal construction. Standard screens are available within the price range indicated by the two curves. The cost to be used must be determined for any given



screen area through knowledge of the degree of refinement that will be required.

The following points may help in making a price selection. Rough scalping and dewatering usually require open units of fairly simple construction. Open units are generally satisfactory for wet sizing, but the construction must be water-tight and the motion suitable for conveying the solids to the discharge. Some materials may splash badly under intense vibration and hence require an enclosed screen. Ordinary construction is suitable if there is no problem of frequent cleaning, rancidity or decay; but for such problems the screen should have a smooth interior, preferably with tubular cross members and filleted joints, while screen cloths should be easily removable for cleaning.

In addition to the basic cost from Fig. 6a it may be necessary to add a percentage for additional features. For the following changes, increase the

basic cost by the indicated percentages: (1) 15% for two-deck construction; (2) 30% for three-deck construction; (3) 12½% for a hopper bottom with discharge port; (4) 25% for totally enclosed construction, with hopper bottom and discharge port. If the unit is to be all-stainless-steel construction, multiply the final cost for the basic screen plus refinements by 2.2.

Costs from Fig. 6a include the necessary screen and motor pulleys and the V-belting, but not the motor or motor control. Motor cost is found from standard cost data after determining the required horsepower for the size and duty of the screen. The latter may be found from Fig. 6b, once the severity of duty is estimated. Table II gives a method of estimating the severity of duty. From the table pick the six "factor numbers" applying to the type of screen and the service. Add these to obtain an "index number" which shows the severity

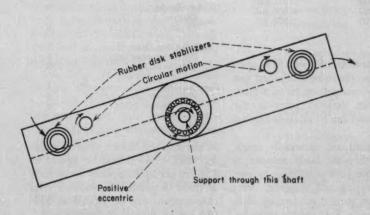
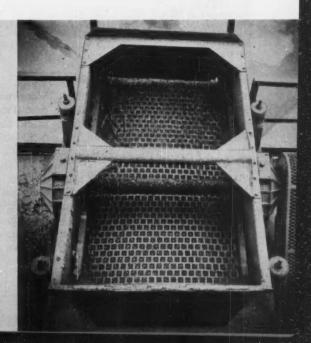


Fig. 5-Positive-eccentric Gyroset screen here removes foreign matter from 50% clay slurry. Fine-mesh screen cloth is reinforced by sweating onto a backing of perforated metal. (Productive Equipment Co.)



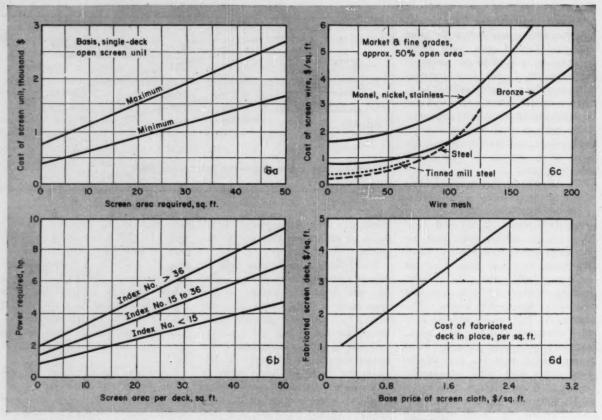


Fig. 6-Rough estimates of wet screen costs can be made with these four charts and use of Table II.

Table I-Approximate Wet Screening Capacities on Various Materials

Material	Mesh	Capacity Per Sq. Ft., Hr.
Pea gravel, sand	3/16-1/2 in.	2 1/2 tons
Soft coal fines	12	3/4 tons
Coal sludge	26	1/2 tons
Synthetic rubber, 5% solids	20	417 gal.
Tomato juice	6	480 gal.
Cannery waste	40	2,400 gal.
Yeast	60	160 gal.
Packing house waste	40	1,800 gal.
Artificial latex	80	180 gal.
Cottonseed oil foots	150	36 gal.
Clay slurry	100	3,240 gal.
CaCO <sub>8</sub> suspension	200	375 gal.
Milk of lime	200	1,000 gal.
CaSO <sub>3</sub> suspension, 27% solids	100	300 gal.

of the duty. Index numbers less than 15 are considered light duty, those tween 15 and 36 medium duty, and those above 36 heavy duty. Fig. 6b gives a curve for each of these duty ranges.

Screen cloth costs are not included in Fig. 6a owing to their great variations. Fig. 6c gives average costs per sq. ft. for standard mesh ranges of steel, tinned steel, market grade bronze, and stainless, nickel and Monel wire cloth of about 50% open area. From the wire cloth cost per sq. ft., the cost per sq. ft. of a fabricated screen deck in place in the screening unit can be estimated by use of Fig. 6d.

These costs are necessarily rough, although they are fairly accurate in covering the cost of cutting to size, binding, edging and shipping. Very fine meshes require reinforcing when used in units 2 ft. wide, or wider.

Table II-"Factor Numbers" for Screens

	Factor Number
Speed: Less than 1,000 rpm 1,000 to 1,350 rpm Over 1,350 rpm	1 4 8
Slope: Over 15° downhill 0 to 15° downhill Uphill	1 4 8
Vibrator: Crank, horiz. plane Offset weight Positive eccentric	1 4 8
Decks: Single	1 4 8
Construction: Open  Bottom hopper only  Totally enclosed	1 4 8
Service: Dry	1 4 8

When made of Monel, nickel or stainless steel, decks should be figured at \$12-\$18 per sq. ft. Special decks, such as those of parallel-bar stainless steel construction, can be figured at \$13-\$16 per sq. ft.

# **Filters**

# J. M. Chalmers, L. R. Elledge, H. F. Porter

The authors have included a considerable amount of know-how in this comprehensive treatment on filtration. The approach is practical and logical, emphasizing latest designs and operating techniques.

A practicing chemical engineer faced with a filtration problem quickly realizes one important fact. He cannot sit down and design a filter from basic equations, as he would a distillation tower or a heat exchanger.

Instead he must rely on technical assistance from filtration equipment manufacturers, on his knowledge of what equipment is available, and on his background of information as to what the equipment can—or cannot—do

We have attempted, in this article, to provide information which will assist the practical engineer with his filtration problems—to improve his ability to select, size, specify and operate filtration equipment efficiently and safely.

This does not minimize the valuable assistance available from the equipment manufacturers. However, it is necessary, in many situations, to form conclusions entirely independent of outside assistance. Or at the very least, to size up a job roughly, before contacting a manufacturer.

Later on, the manufacturer's recommendations should be carefully evaluated.

We emphasize newer types of equipment here. And more recently developed features of conventional equipment which have not previously been fully covered in the literature. Discussion of older types, already described in handbooks and catalogs, is kept to a minimum.

We also emphasize continuous vacuum filtration. Best present day practice in chemical plants leans more and more toward this type of operation on large scale production. There are many more variations and complications in all phases of continuous vacuum filtration work, than in the simpler and more straightforward batch operations.

In an article of this kind, it is im-

possible to cover all types and varieties of filters. Omission of any filter should not be construed as an indication that such a unit cannot be competitive with those described.

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# Filtration Theory and Research

In discussing filter theory, one point should be emphasized—the vast majority of filters continue to be installed on the basis of empirical laboratory or pilot plant tests. These tests are designed to determine slurry filtration characteristics after a preliminary selection of filter type has been made. This preliminary selection may be based on previous knowledge or observation of the material; or, if necessary, on high-spot laboratory tests.

The major contribution of theory to the work of the practical filtration engineer still lies in the field of interpretation of such tests to: (a) determine the optimum cycle and (b) predict effects of changing operating and process conditions on existing equipment

An adaptation of Poiseuille's equation is generally considered to be the basic cake filtration equation:

$$\frac{dV}{A d\theta} = \frac{g_e \times \Delta p}{(\alpha W/A + R_m)\mu}$$

where V = volume filtrate.

A =filtering area.

 $\theta = time.$ 

 $\Delta p = \text{total pressure drop through }$  cake and filter medium.

 $\mu = filtrate viscosity.$ 

W= weight dry cake = wV, where w= weight of cake forming solids per unit volume of filtrate.

 $\alpha$  = average specific cake resist-

 $R_{\rm m}=$  pressure drop other than through cake (resistance of unit area of filter medium, pressure drop in piping, etc.).

g<sub>e</sub> = gravitational conversion factor.

Bellas (Perry, J. H., "Chemical Engineer's Handbook," 3rd Ed. McGraw-Hill Book Co., Inc.) and others have thoroughly examined this equation under different filtration conditions to show how it can be used to predict effects of process changes and to interpret test work. This material need not be repeated here. But since it represents a practical and useful tool it might well be consolidated as a general set of rules.

• For incompressible cakes (i.e., granular beds which do not consolidate under pressure) the filtration rate is directly proportional to the viscosity, to total amount of cake or filtrate, and to the specific filter cake resistance.

• For the theoretical case of a highly compressible cake, where the average specific cake resistance ( $\alpha$ ) increases directly with the pressure drop ( $\Delta$ p), the filtration rate would be independent of pressure.

• Most cakes encountered in chemical work are compressible to some extent between these extremes. At the present time the exact variation of a with  $\Delta p$  can only be determined experimentally for a given feed suspension. But in general the more flocculated the suspended solids, the more compressible the deposited filter cake.

 The average filtration rate during a cake filtration is inversely proportional to the amount of cake deposited.

• Filtration rate is inversely proportional to the ratio of solids to fil-

trate. Rate of cake formation is directly related to this ratio.

• The above rules assume that filter medium and other hydraulic resistance (R<sub>m</sub>) is negligible as compared to cake resistance. This is most often the case in cake filtration.

• When a constant pressure test

is run on a slurry a plot of 
$$\frac{\Delta \theta}{\Delta V/A}$$

(as ordinate) against V/A (as abscissa) results in a straight line with slope  $\mu w/2\Delta p$ . The intercept of this plot on the vertical axis is  $\mu R_m/\Delta p$ . When  $\mu$ , w, and  $\Delta p$  are known,  $\alpha$  and  $R_m$  can be calculated by:

$$\alpha = \frac{\mathbf{g}_{\mathrm{c}} \, 2\Delta p}{\mu w} \times (\mathrm{slope})$$

$$R_{\rm m} = \frac{g_{\rm s} \, \Delta p}{\mu} \times ({\rm vertical \; intercept})$$

 The affect of pressure is determined by running tests at other pressures and calculating the corresponding a and R<sub>m</sub> values.

Usually  $\alpha$  varies with pressure, and the variation has been shown to be a complex one which cannot be plotted as a straight line. Therefore, it's not safe to extrapolate a plot of  $\alpha$  vs.  $\Delta p$  very far beyond the pressure range covered by experiment. However, it has been shown that  $R_m$  varies nearly in proportion to  $\alpha$  and that it is usually safe to estimate  $R_m$  equivalent to 0.1  $\alpha$ .

#### Recent Developments

More recent and more rigorous approaches to filtration theory have been discussed by Miller (Miller, S. A., Chem. Eng. Prog. 47, No. 10, p. 497, 1951). Such work is of great importance in furthering the understanding of basic filtration mechanisms. But the application of a more rigorous theoretical approach in practical filtration has not been widespread.

A relatively recent development in filtration research, with direct practical value, is the compression-permeability cell technique described by Grace (Grace, H. P. Chem. Eng. Prog., 49, pp. 303-318, 367-377, 427-436, 1953). In applying this technique, a single cake is formed in the cell by filtration of the slurry at 1 to 2 in. of Hg vacuum. This cake is then subjected to uniform mechani-

cal pressure from a porous-ended piston, while filtrate is passed through the cake under a small gravity head.

Measurements of specific cake resistance, cake porosity, and effective specific surface are made as the mechanical pressure on the cake is increased stepwise by application of weights or by use of a press. With such knowledge available for a particular slurry, it's possible—by means of the standard filtration equation—to explore a wide range of filtering conditions by calculation. Only the basic data for the single compression-permeability run is needed.

This technique is useful particularly in the early stages of a filtration problem. At this point enough may not be known about the slurry to indicate whether vacuum or pressure is the best choice; or enough material may not be available for conventional filtration tests. Also, this technique is very useful in quantitatively characterizing the feed suspension, and changes in this feed suspension which occur with changes in preparation.

### Theory of Filter Media

Another field of practical filtration research, which is quite useful, is that of filter media evaluation. The development of many new synthetic fibers in the past several years has made filter media available with much improved chemical and temperature resistance. On the other hand the problem of filter medium selection has been greatly complicated—hundreds of new styles and designs have been introduced. In many cases a single medium will be offered by numerous vendors under different designations.

Grace has described ("Structure and Performance of Filter Media, Part 1 and 2," 21st Annual A.I.Ch. E. meeting, Dec. 12-15, 1954, N. Y.) a selection procedure based on laboratory measurement of average pore size, size of maximum pore, pore size distribution, air and liquid permeability, and several other characteristics. This knowledge has made it possible, by preliminary selection; to greatly reduce the number of media for actual test work.

There is a long-range objective of filter media research. This is towards development of specifications for a relatively small number of weaves and constructions in the available materials. These specifications would cover the entire filtration range. This would tend to eliminate the many duplicate styles, the continual introduction of new styles, and the discontinuance of established styles. Grace has taken the first step toward this objective. He has determined the effects of filter medium construction on the pore size distribution. And he has evaluated filtration performance of many representative filter media.

#### Laboratory Test Work

As stated at the beginning of this section on theory and research, most filters are installed on the basis of empirical tests. It, therefore, will be useful at this point to discuss such test work briefly. Preliminary to actual test work, it is always important to define the filtration problem and to record all readily available information. This is shown in the convenient questionnaire form which can be used for this purpose. All of the information listed may not be readily available. In fact all of it may not be essential to a solution of the particular problem. However, it provides a convenient check list for getting as much pertinent data as possible.

Usually either vacuum or pressure filtration is decided upon before final testing. In the case of continuous vacuum filtration, simple laboratory leaf tests are generally used. Since such tests are relatively short and easy to perform, it is usually best to make quite a few runs to fully explore the variables.

The most important consideration here is the closest duplication possible of the proposed filter cycle in order to determine the limiting variable on filter capacity. This can be either cake forming time, washing time, or cake dewatering and drying time. A sufficient number of runs should be made (usually four or five) for each of these parts of the cycle so that basic curves can be plotted.

It is necessary first to determine the minimum time to form a dischargeable cake, under varying vacuum levels. Using this cake forming time, at optimum vacuum, a series of washtests are made. This establishes the number of wash displacements and the time for the degree of purity required. Finally, a third series of tests is made to determine the time required for drying the cake after washing. This information—coupled with a knowledge of filter design and operating principles—permits the determination of the optimum over-all filter cycle and size of filter equipment.

For pressure filtration, tests require more complicated equipment, take longer to perform, and are more difficult to observe. Therefore, a minimum number of constant pressure tests are usually run. And the results are interpolated and extrapolated to calculate the optimum cycle and operating conditions. These data can be used to approximate cycles for constant rate filtrations. And (though more complicated) also used for the case of feeding a pressure filter with a centrifugal pump, where rate and pressure both are constantly changing. In batch pressure filtration either filtration rate or cake-holding capacity may be limiting on filter size and cycle time.

The compression-permeability cell technique is a tool which can be effectively applied to pressure filtration test work.

Only a single, simple test is necessary to predict performance under any pressure conditions, or with any type of filtration feed cycle.

#### Sizing the Equipment

Safety factors, applied when sizing either vacuum or pressure filters based on laboratory work, may vary from a low of 20% to 100%. The actual value will depend upon how representative the tested sample may be; probable variations in slurry filterability and production rates; and sometimes sizes of available commercial equipment.

Probability of plant expansion is often a factor in sizing equipment, especially where potential capacity may be made available by a relatively small incremental cost in process filter equipment.

Pilot plant investigations are sometimes justifiable on the basis of lowering the safety factor. Such investigations are also useful to explore possible difficulties not readily evaluated with laboratory tests—cloth blinding, cake

	Filter Questionnaire
Reason for study:	
Increased capa	acity; Improved quality; Cost reduction
Salety; 1	New facilities; New process; Other
Desired filtration	
	Solids, Liquids, Both
Solids:	Max. dryness; Washed; Washed & max. dry
	Thickened; Min. dilution; Separation
Process description	
Continuous	Max. rate //hr.; Av. /hr.; hr./day
Batch:	lb./batch;hr./batch;batch/day
Functional proc Existing metho	cess description (detail on flowsheet) d:
Desired metho	d:
Alternative me	ethod:
Hazards:	
Value of materia	le.
Name:	
Cost:	
	TOTAL
Utilities: Ele	ectric Steam Comp. air Fresh Water Cooling  vppsipsipsi. kwh M lb M cu.ft M gal
Utilities: Ele Units:c Cost: \$	vppsipsipsi
Utilities: Ele Units:c Cost: \$	.vppsipsipsi
Utilities: Ele Units:c Cost: \$	vppsipsipsi
Utilities: Ele Units: c Cost: \$ Filter media Existing: Alternates:	v p psi. psi. psi. kwh. M lb. M cu.ft. M gal. Material Supplier Designation Remarks
Utilities: Ele Units:c Cost: \$ Filter media Existing: Alternates: Filter aid: (Nai	wh. M lb. M cu.ft. M gal  Material Supplier Designation Remarks  Supplier Supplier
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Utilities: Ele Units:c Cost: \$ Filter media Existing: Alternates: Filter aid: (Nai Prec Slurry conditione Feed pump: Solids size & form	
Utilities: Ele Units:	No.   Posi
Utilities: Ele Units:	Not easy   Since
Utilities: Ele Units:	Naterial Supplier Designation Remarks  Material Supplier Designation Remarks  Material Supplier Designation Remarks  Memory Supplier Designation Remarks  Memo
Utilities: Ele Units:	Not easy

discharging, wash liquor run-off, etc. Nevertheless a high percentage of the filters installed on new processes are based on laboratory test work only. It should be kept in mind that pilot plant testing costs money which might often be more wisely invested in somewhat larger equipment.

tion level is usually still a more important factor.

# How to Select a Filter

Even rough preliminary selection of a specific filter type is a complicated and involved process. A large number of factors must be considered. It is quite difficult to describe all of these factors in their proper light since relative importance varies widely in different filtration problems. However, we've tried in this discussion to give an engineer-when confronted with a filtration problem-a better insight into the important work of judging which filter appears to be the best answer. This, then can form the firm basis for work which follows: choosing, sizing and specifying a particular filter. Of course, this firming up can be done with the assistance of filtration equipment manufacturers. Or it can be done independently.

#### What Are the Factors Involved?

There are five major factors which determine the most economical filter selection. They are: (1) slurry filterability or cake formation characteristics; (2) production level; (3) required process conditions; (4) required process results; and (5) materials of construction. Any one of these, in a given problem, can be the most important over-all.

Slurry filterability—or more precisely the cake formation characteristics of a slurry—immediately indicates whether truly continuous filtration can be used, or whether continuous precoat or batch operation must suffice. In general, if a ½-in. thick cake cannot be formed at around 20 in. Hg vacuum (or 10 psig.) pressure drop in 5 minutes or less, then continuous filtration is not practical.

Continuous filtration is often indicated on slurries which range from this lower limit in cake formation—through cases of extremely free filtering materials from which 2 in. or thicker cakes can be formed in a matter of seconds. Within this range the cake formation characteristics, along with other factors to be discussed below, are quite important in deter-

mination of the most logical specific equipment type.

Below this range of cake formation characteristics, continuous precoat or batch methods should be used. This includes solution clarification where no appreciable cake is formed during the entire filtration cycle.

The next factor to consider is that of production level. Continuous operation is generally economical and desirable at relatively high production rates because of labor savings. It becomes more and more difficult to justify at lower rates down to and including pilot-plant production operation.

Of course, if continuous operation is strongly indicated for a subsequently planned large scale plant, it is often desirable to install relatively expensive pilot scale continuous equipment in the semi-works to get basic operating data. Many times such equipment can be rented or borrowed from the manufacturer.

#### Process Can be Limiting

Required process conditions sometimes virtually dictate filter selection by severely limiting the choice. For example, vacuum may not be possible because of temperature or vapor pressure limitations. This narrows the possibilities to relatively expensive pressure filters (continuous pressure filters or continuous pressure precoat filters) or to batch pressure units. Temperature and chemical resistance may limit the choice of filter media which may in turn strongly affect equipment type.

If volatile, explosive, or toxic materials are being handled, a totally enclosed filter is necessary. Such a requirement may indicate the choice of batch methods rather than use of relatively expensive vaportight continuous filters.

The nature of the process, whether it is batch or continuous, may influence the choice between continuous and batch filtration, although producRequired process results are of particular importance in deciding which specific unit of a general type might be the best choice. Thus, if continuous filtration is indicated, washing requirements and degree of filtrate wash separation necessary have considerable influence. Likewise, if batch filtration seems logical, then the permissible means of cake discharge (whether it may be sluiced away or must be recovered dry) as well as washing requirements become significant.

Materials of construction, as a factor in filter selection, are of special importance because of their influence on filter cost and fabrication difficulties. For example, sometimes what usually would be a continuous vacuum filter application might be more economical using a more simply designed and fabricated batch filter. This is mainly because of the high cost of materials of construction.

It is recognized more and more that very detailed specifications of materials of construction for all types of filters is of utmost importance for prevention of operating difficulties and high maintenance costs.

#### How to Use Filter Chart

The chart shows the influence of these major factors in filter selection. Five categories of slurries have been arbitrarily defined according to cake formation and porosity characteristics, solids settleability, and solids concentration.

The first four categories cover the range of cake filtration. Grace defines cake filtration (Chem. Eng. Prog. 47, No. 10, p. 502) to be the filtration mechanism primarily involved when handling slurries of more than 1% solids concentration. Category E is really not strictly a slurry and represents a solids content of less than 0.1%, where the mechanism of solution clarification is dominant.

Again as previously pointed out by Grace, the range between 0.1% and 1% solids is the region where both cake filtration and solution clarification mechanisms are significant. This range should be avoided if possible by means of prethickening or addition of filter-aid.

Specific Equipment	Remarks	Slurry Category				
		A	В	C	D	E
Continuous vac. drum	Bless State S					
Multi-compartment	100.1		X	X		
Single compartment	2	1	X	X		
Dorrco	-3	X	X			
Hopper dewaterer	4	X	××××			
Top feed	5	X	X			
Continuous vac. horizontal						
Scroll discharge	6	X	X			
Tilting pan	7	X	X			
Belt	8	X	X			
Continuous vac. disk	9		×××××	X		
Continuous pres. drum	10		X.	X		
Continuous pres. disk	11		X	X	v	v
Continuous vacuum precoat	12				X	X
Continuous pressure precoat	13		V	V	×	×
Batch vacuum leaf	14		0	0	X	X
Batch nutsche	15		^	^	^	^
Batch pressure filters	4 42 8000		V	V	V	v
Plate and frame	16		0	0	<b>\$</b>	0
Vertical leaf	17		XXX	XXXX	×××	XXXX
Tubular element	18	X	Ŷ	0	Q.	0
Horizontal plate	20	^	^	^	^	0
Cartridge, edge	20	Y	Y			^
Centrifugals		Ŷ	Ŷ			
Mechanical screens, shakers	22	^	^			

#### Slurry Categories

#### Category A

Usually contains greater than 20% solids. Very rapid cake forming (2 in. or more cake thickness in a few seconds).

Fast settling (cannot be kept in suspension by conventional drum filter agitator). Cake is difficult to pick up from the filter tank and hold on the drum by vacuum large particle sand in water.

Continuous filter rates would be 500 or more lb. of dry solids/hr./sq.ft. of total filter area.

Usually has greater than 10-20% solids. Rapid cake formation (1/2 in. thick in at most 2 min. Up to 2 in. thick in 30 sec). Fast settling, but can be kept in suspension by standard drum filter agitator.

Cake can be picked up and held on drum by vacuum (corn starch in water)

Continuous filter rates would be between 50 to 500 lb. dry solids/hr./sq.ft. of total filter area.

#### Category C

Solids concentration here is from 1 to 10% or more.

Slow cake formation (at least 1/4 in. thick in 3 min. Up to 1/2 in. thick in 2 min.). Normal settling.

Thin cakes form on continuous drum filters and are usually difficult to dis-charge (finely precipitated calcium carbonate in water).

Continuous filter rates are in the range 5 to 50 lb. dry solids/hr./sq.ft. total filter area.

#### Category D

Solids concentration is low-less than 5%. Normal settling, and slow cake formation (less than 1/4 in. thick in 5 min.).

A dischargeable cake cannot form on a continuous filter in a reasonable time

(very low concentrations of activated carbon in water).

Batch filter rates are usually considerably less than 2 lb. of solids/hr./sq.ft. of filtering area. As a filtrate rate, capacities would range from less than 1 gal. filtrate/hr./sq.ft. of area to more than 100, depending on conc., nature of solids, viscosity, etc.

#### Category E

Solids concentration less than 0.1%.

No cake formed during filtration cycle; solution clarification applies. Batch rates, expressed as filtrate, vary as widely as in category D.

1. Where vacuum can be used and with large scale production, the conventional drum filter is the most generally applicable for categories B and C. With few exceptions other continuous filters are more expensive. Their cost must be justified by reasons of some distinct advantage conventional unit.

2. Applicable rather than conventional 2. Applicable rather than conventional drum in cases where high speeds and thin cakes can be utilized to give higher cake and washing capacity. Also, where extremely sharp wash separation is required. Usually can discharge thinner cakes than other continuous filters.

3. Applicable to category A, and sometimes borderline category B slurries where solids are fast settling but cake can be held on the surface of drum with vacuum. Modest degree of washing is possible.

4. Especially applicable to category A a. Especially applicable to category a (large-scale production) when cake is so porous that it cannot be held on the Dorreo surface with reasonable vacuum pump capacity. High degree of washing cannot be attained.

5. Especially developed and generally used, as combination filter-dryer gory A and borderline category B slurries. A modest degree of washing is possible.

Applicable in category A when a high degree of washing, better wash separa-tion, or countercurrent washing is desired.

Also, when cake is so porous that it cannot be held on the drum by vacuum. Sometimes justifiable in category B on the same basis. Generally more applicable for slurries from which a minimum % in. thick cake can be formed in a rearchal learth of time (20 to 60 seconds).

sonable length of time (30 to 60 seconds).
7. In general, comparable to the scroll discharge horizontal. However, because of more complete cake discharge, this type can operate with a thinner cake and gives a sharp separation between washes— about equal to that of the single-compart-ment drum filter. Also, there is little tendency for cloth blinding.

8. Comparable to the tilting pan hori-

zontal in method of cake discharge, cept that a blowback cannot easily applied. The filtering area can be used for 40% of the filtration cycle compared to around 80% for other horizontal types. Therefore, it is more expensive per unit effective area.

9. Less expensive and occupies less floor space per unit area than conventional drum filter. Often least expensive continuous vacuum filter for categories B and C where wash requirements are low.

10. Useful in large scale production in categories B and C, where pressure must be used because of temperature and vapor pressure limitations on vacuum or where flammable or toxic materials require en-closed construction. In general, equivalent to its vacuum counterpart in performance, except that usually you get higher filtration rates.

11. Like the vacuum counterpart, this

filter is usually less expensive than pressure drum with low wash requirements.

12. Used primarily in large-scale solu-12. Used primarily in large-scale solu-tion clarification at low viscosities. Some-times economical in category D when highly resistant, very thin cakes are formed quickly. However, cake will be contaminated with filter-aid.

13. Same as the vacuum counterpart where pressure must be used.

14. Moore filters are used primarily on large tonnages in categories B and C. Usually strong filtrate recovery is important and corrosion problems are difficult. The tendency is away from this type of operation towards continuous.

15. Most often used for pilot plant or very small scale production. Nutsches are

the most simple of filter construction, par-ticularly suited to categories B and C. 16. Presses are still the most widely used of all filters. Practice in present day plants tends toward continuous filtration where vacuum is possible-or towards pressure leaf filters on the basis of labor savings. Presses are usually the best choice for high viscosity, large scale production solution clarification. Low cost, low floor space per unit area. Usually small-scale production for category C, both small and large-scale in categories D and E

17. Often the most economical selection for category D, especially where cake sluicing can be used. Also useful for low scale production in categories B, C, and D, as well as in solution clarification, where it is usually used with precoat.

where it is usually used with precont.

18. Competitive with vertical leaf filters in categories B, C, D and E, except where a dry cake discharge is necessary. High pressure back wash to discharge cake is often superior to sluicing (used with veroften superior to sluicing (used with ver-tical leaf filters). Good for solution clari-fication when precoated.

19. Can be used for same services as

vertical leaf and tubular element pressure filter. Especially good where interrupted service is required. However, the cake cannot be sluiced and dry cake discharge requires considerable labor. Will handle category A slurries satisfactorily on small scale. Most applicable to solution clarification, with precoat or filter paper.

20. Used primarily for solution clarification, or removal of contamination.

21. Competitive and often superior in categories A and B. 22. Competitive and sometimes superior in categories A and B, especially if gravity drainage is satisfactory.

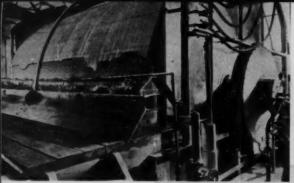
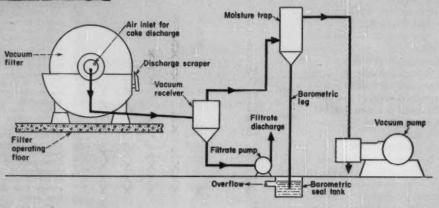


Fig. 1—The multiple-compartment rotary vacuum filter consists of a cylindrical drum rotating in an open top slurry tank. Cake discharges with the help of a scraper blade, and an air blow. (Dorr-Oliver, Inc.)



The chart is arranged so that various filters applicable to the five categories are indicated. Remarks about each filter are included which, along with this discussion, are intended to permit the most logical selection.

Remember that in any such an arbitrary classification as this there are bound to be some overlapping cases where a given slurry may seem to fit in two categories, or in a borderline between categories.

In such cases the remarks on the chart and the discussion should point to a logical selection.

#### Slurry Categories

· Category A is defined as a slurry from which a thick cake (2 in. or more) can be formed in a few seconds. The solids are fast settling. It would be impossible to hold them in suspension by means of the standard agitation in a conventional drum filter tank. Solids concentration in such slurries is naturally quite high; otherwise the material would usually be thickened prior to filtration. When large scale continuous vacuum filtration is desired, porosity of the cake from such a slurry determines whether it can be held by vacuum on the drum of a Dorreo internal drum filter, or on a top feed unit. If not, the hopper dewaterer, or one of the horizontal types is indicated. High washing or

wash separation requirements indicate a horizontal type.

With small scale production, batch nutsche filters are often used with this type of slurry. If pressure is required an enclosed nutsche or horizontal plate pressure filter can be used, for small production rates.

For large scale production, with pressure required, probably some other type of equipment such as a continuous centrifuge should be selected. However, any of the vacuum filters applicable to this category could be designed with a pressure closure.

This category of slurry is encountered more often in the mining and metallurgical field than in the chemical industry. It is included primarily to define the limitations of other more commonly used equipment.

Particularly in this category other methods of solids-liquid separation such as centrifuging, screening, or even settling and draining, are superior or competitive to filtration.

• Category B is limited by slurries from which at least a ½-in, thick cake can be formed in 1-2 minutes. These figures, and other similar ones to follow, define filterability and not optimum filter operating conditions. The upper limit on filterability for this category is around a 2 in, cake in 30 seconds. If faster filtering, it will fall in category A. Settling rate is usually

such that a suspension can be maintained by drum filter tank agitators. Solids concentration is again usually relatively high. Cake porosity is such that cakes formed can be held on drum filters by vacuum.

For continuous large scale vacuum filtration, the conventional multiple-compartment drum filter is usually the most economical choice. If wash or wash separation requirements are high, alternates may be justified. If wash requirements are low, the continuous vacuum disk filter may be more economical than the conventional drum.

For small scale production, batch nutsches and batch pressure filters are often used for slurries in this category. If pressure is required, a nutsche, horizontal plate or vertical leaf pressure filters, tubular element filters, or a filter press is used depending upon allowable method of cake discharge and scale of production. For high production with pressure operation, either a continuous pressure drum or a continuous pressure disk unit may be used, depending on wash requirements.

Again in category B, centrifuging and screening must always be considered.

• Category C represents the lower limit of continuous filtration (\frac{1}{2}-in. thick cake in at most 5 minutes at 20

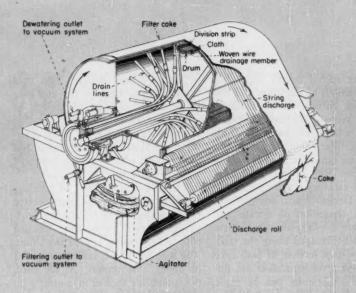


Fig. 2-A string discharge filter is a variation on the standard drum filter. The strings pass around the drum and over the roll, lifting the cake. (Filtration Engineers, Inc.)



in. Hg vacuum) up to the lower limit of category B. Solids settling characteristics are usually normal and solids concentrations may range from 1% up to 10% or more. Cakes handled are usually thin and difficult to discharge from a continuous filter. This is because only a very thin cake can be formed in a reasonable time; or because much higher filtration rates are obtained with a thin cake, though a thicker cake could be formed.

For continuous large-scale vacuum filtration the conventional multiplecompartment drum filter is again usually the most economical choice here. The single compartment drum is superior in discharging very thin cakes and where high washing efficiency and sharp wash separation are required. The continuous disk filter may be more economical than the conventional drum if wash requirements are low.

For extremely high production requirements, coupled with corrosive conditions, and the necessity of producing very strong filtrate with a thorough cake wash, slurries from categories B and C are sometimes handled on batch vacuum leaf (Moore) filters.

scale production, With small nutsches and batch pressure filters can be used. If pressure is required a pressure nutsche, horizontal plate or vertical leaf pressure filter, tubular element filter, or a filter press is used depending on scale of production and allowable method of cake discharge. Again, for high production in this category, requiring pressure, the continuous pressure drum or continuous disk may be used.

· Category D represents slurries that will not form cakes which can be discharged continuously in a reasonable period of time. Solids concontration is usually relatively low (less than 5%). There is seldom any solids settling problem. Continuous vacuum or pressure precoat operation is sometimes justified in this case with high scale production. Otherwise, batch pressure methods are indicated with the choice depending primarily on scale of production, permissible cake discharge methods, wash requirements, etc.

# Commercial Filtration Equipment

In this section we will discuss the various types of commercially available filtration equipment-how they work, what they are best fitted to do. We will cover four major categories: continuous vacuum, continuous pressure, batch vacuum and batch pressure filters.

· Category E is defined as suspensions containing less than 0.1% solids. Solution clarification rather than cake filtration is involved. Solution viscosity and particle size have more influence in this case. For relatively large particle size separation (5 microns or more) either continuous or batch precoat filters, filter presses, horizontal plate filters, edge or cartridge filters are used, depending upon production level. For high viscosity solutions, presses or cartridge filters are most applicable.

For fine separations (5 microns or less) from low viscosity solutions, precoated batch pressure filters are often used. At high production levels in this case, continuous vacuum or pressure precoat filters can often be justified. High viscosity solutions, with solids of less than 5 microns usually require a precoated plate-and-frame filter press.

We will also cover important auxiliary and accessory equipment.

### Continuous Vacuum Filters

For large-scale operations, continuous vacuum filters are widely used in the chemical industry.

#### Multiple-Compartment Rotary Drum

The basic rotary drum filter has been covered in Perry's Handbook (3rd Ed.). The following discussion includes enough similar material to provide an understanding of the operation of the unit, and a basis for comparison to other types of continuous vacuum filters.

It's presented in such a way as to emphasize design features not previously well covered in the literature. These features have been developed to improve the performance and the versatility of the standard drum filter.

A standard unit consists of three major parts: the drum with automatic filter valve; the filter tank with slurry agitator; and the scraper or doctor blade for cake discharge. The drum rotates about its horizontal axis and is suspended in the slurry contained in the filter tank (Figs. 1 and 2).

The surface of the drum is divided into a number of shallow sections (usually 12 to 24, depending upon drum diameter) having suitable drainage decks or grids for supporting the filter medium and providing passage to the section outlets. The sections are sealed from each other by means of longitudinal division strips.

Each section is an individual compartment connected by means of filtrate piping to the automatic filter valve located on the trunnion at one end of the filter. Each section also has one or several outlets depending upon the length of the drum and the amount of filtrate to be handled. Multiple section outlets are manifolded to a larger common pipe leading to the filter valve. Outlets from each section can all be arranged along the leading edge of the section if maximum cake dryness is required.

maximum cake dryness is required.

Some Design Variations—Where maximum separation of filtrate and wash liquors is necessary, the outlets are normally arranged along the trailing edge of each section. If both cake dryness and good separation are important a compromise can be made by using both leading and trailing edge piping. Fig. 3 shows this.

In very special cases, where it's essential to have both sharp separation of liquors and maximum cake dryness, two automatic filter valves can be provided, one mounted on each end of the drum. All leading edge piping connects to one valve and all trailing edge piping to the other. The automatic valves are so adjusted that on the rising side of the drum, vacuum shuts off on the leading edge piping and full vacuum is applied to trailing edge piping. As each section passes top center, the vacuum is shut off from the trailing edge piping and applied to the leading edge. This arrangement is a costly one and adds considerably to the filter price.

Recent Trends—For fast filtering materials with high liquor and air flows, there is a recent development in filtrate piping design. This uses the largest possible pipe size and long radius bends in place of fittings, to reduce pressure drop. Remember that the number and size of pipes determine the diameters of trunnion and filter valves, which in turn represent an appreciable part of filter cost.

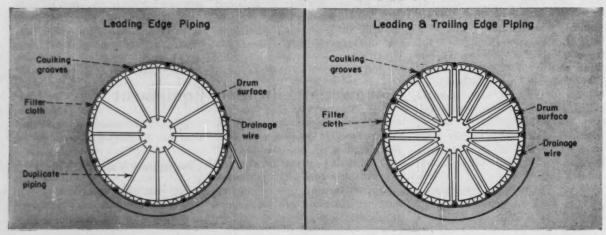
The common method of securing the filter medium to the drum surface is by caulking the cloth into the longitudinal division strips, then winding wire under tension around the drum. The wire winding is uniformly spaced on about 2 in. centers. At the ends, 6-8 strands are applied in contact with each other to provide sealing.

The panel type method of securing the cloth has been developed to permit the discharge of thin cakes and retard filter medium blinding. Thin cakes result in higher filter capacity, because the relatively high rates obtained during initial cake formation are used.

This development has made the use of conventional drum filters possible, on materials which could not be handled on wire-wound drums. As with wire winding, the cloth is caulked into the longitudinal division strips.

Grooves must be properly dovetailed to securely hold the cloth in place without the assistance of wire winding. Ends are sealed either by similar caulking or by bands or wire winding. The cloth bellows out and stretches somewhat when blowback

Fig. 3-For the requirement of maximum filter cake dryness, internal piping should be arranged along the leading edge of the filter sections. For both cake dryness and separation, both trailing and leading edge piping is used.



air is applied at the point of cake discharge. A floating type scraper follows the contour of the inflated cloth. Disadvantages in the panel type operation are: difficulty in holding the cloth in place and, in general, increased cloth abrasion due to the rubbing action of the scraper.

How Important Is Submergence?— The most common filter tank is designed for about 40% circumferential submergence. This makes it possible to locate the tip of the scraper blade below the drum horizontal centerline. An almost vertical scraper blade can be used. This often allows the filter cake to fall freely from the drum surface without scraping.

There is another reason for this common submergence. It's the maximum obtainable without the use of trunnion stuffing boxes. Elimination of such stuffing boxes is desirable for maintenance and good housekeeping. Remember that the maximum effective submergence which can be subjected to vacuum is less than the actual 40% submerged area. To prevent a vacuum leak, the automatic valve must be set so that the trailing edge of a section is fully submerged before vacuum is applied. For example, with a 12 section drum and a 40% submergence tank, the maximum effective submergence is a little more than 30%.

Where cake capacity of the filter is limiting, maximum submergence is important to minimize the size of the unit. Submergence up to 60-65% circumferential is often used; but this requires an arrangement with trunnion stuffing boxes.

Maximum submergence is determined by the highest position of the scraper blade at which the filter cake can be effectively discharged. This position is naturally higher for thick, easily discharged cakes than for thin, sticky cakes.

Many recently developed processes require completely closed filters to permit the use of an inert gas system. Such a system can be necessary for many reasons: prevention of air oxidation of the product, loss of valuable solvent vapors, and escape of flammable, toxic or lethal gases.

Naturally, such a filter is much more expensive to fabricate than an open unit. Stuffing boxes or other sealed closures are required regardless of submergence; and large rugged flanges are needed to insure tight gasketed joints. Another problem introduced by this construction is the more complicated cake discharge arrangement. It must also be vapor tight.

Variable Submergence—For variable submergence control, a widely used standard device is represented by the drop plate weir box (Fig. 4). It consists of an overflow box on the side of the filter tank, with grooves into which a varying number of weir plates are placed. This gives stepwise control over drum submergence. But it is relatively troublesome (especially

in a closed filter) to change from one submergence to another.

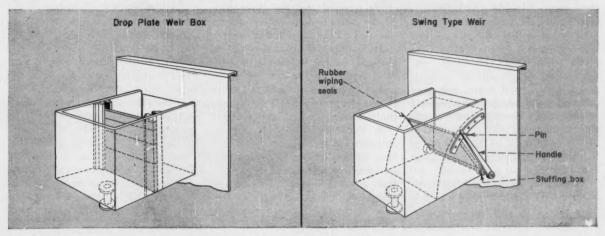
For this reason the swing-type weir shown in Fig. 4 has been developed. The weir plate is easily adjustable from outside the box even if the filtration system must be closed or vapor tight.

Development in filter tank agitators has been toward pin mounting above the trunnions to eliminate the large bearings needed when trunnion mounted. Better results are obtained if the bottom of the filter tank is concentric with the path of the agitator and with minimum clearance (consistent with normal fabrication) between the tank bottom and the rakes.

Clearance between cake surface and agitator rakes should be specified according to the expected maximum cake thickness, and the tendency of the cake to be swept off the drum by the agitator motion. It is good practice on materials which are easily swept off the drum to provide a variable speed drive for the agitator. This allows adjustment to the lowest speed at which the solids can be kept in suspension.

Control of Drum Filters—Control is of great importance for getting optimum results. There are three major variables which are used for this purpose: drum speed, vacuum, and drum submergence. To obtain maximum cake capacity by means of these variables the drum should (a)

Fig. 4—Weir boxes are helpful in variable submergence control on rotary drum filters. A drop plate weir, on the side of the filter tank, gives stepwise control. A swing-type weir permits easy adjustment of submergence.



be run as fast as possible while still producing a dischargeable cake, (b) the highest practical vacuum should usually be applied and (c) the maximum drum submergence should be used. These conditions must be consistent with any wash or cake dryness requirements. In other words, either washing or cake drying may be the over-all limiting factor on filter capacity, rather than simply cake capacity.

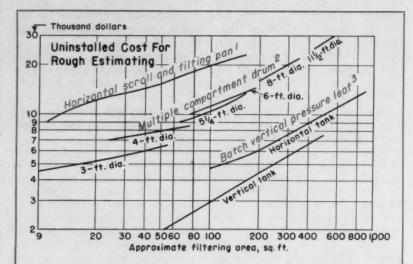
It is standard practice to provide drum filters with a variable speed drive. Reliable automatic vacuum controls are available if needed. In many cases of a fairly uniform slurry and a relatively constant flow, the drum speed and vacuum are set and the submergence allowed to vary with small process changes. Where possible, this is a good way to operate a filter since it then becomes an automatic surge point in a continuous sys-

tem.

In other cases, however, where it's necessary to control the filter operation itself a little more closely, it's desirable to fix the drum submergence and vary the drum speed. This is done with a constant overflow connection from the filter tank back to the slurry feed tank. Or with a feed control actuated by the filter tank level.

The next step in degree of filter control is by varying submergence. Either the drop plate weir or the swing-type weir (both described above) can be used. The choice will depend on how accessible the weirs have to be, how frequent adjustments will be made. and corrosion or other hazards. There is one drawback to varying the submergence by means of either of these weirs. If a low submergence is ever needed, the automatic filter valve must be set so that cake pick-up does not begin much before bottom dead center on the filter. Otherwise, vacuum would be lost through each exposed section as it moves from the point of cake discharge to the point of submergence. Therefore, with a variable submergence device, that portion of the cycle must be blanked off in the filter valve. This, of course, sacrifices capacity.

In one very special case this drawback was eliminated by using a double valve filter. The unit had to be operated intermittently on two slurries of



- Open type. Fabricated carbon steel con-struction. Four solution automatic valve. Wash apparatus and variable speed drive included. Solid stainless or rubber covered steel construction will double costs. One manufacturer offers sizes up to 500 sq. ft.
- Open type. Fabricated carbon steel construction. Normal submergence (approx. 40%, depending on maximum available without trunnion stuffing boxes). Swing type agitator; panel or wire wound drum;

two solution automatic valve. Wash ap-paratus, variable speed drum drive in-cluded. Solid stainless or rubber covered steel construction will about double above costs.

Fabricated carbon steel tank. Type 304 stainless steel leaves and internal filtrate manifold. Quick opening closure. Units are available in almost any specific in-termediate size. All stainless construction will raise above costs about 50%.

extremely different filterability. A high degree of flexibility and control was needed in each case to obtain optimum capacity and washing efficiency. One required variable submergence in the very low range and the other required this variability at close to maximum submergence.

One automatic valve was set with its cake pick-up (cake forming) part of the cycle close to the maximum submergence obtainable on the filter. This valve was used for the slower filtering material, and the other valve, set for bottom dead center pick-up, was used for the fast filtering slurry.

The setup, therefore, could be changed quickly by means of hand valve settings in the external filtrate piping, from one slurry to the other. It provided maximum flexibility and controllability for each material.

A Versatile Unit-The multiple compartment rotary drum filter is the basic continuous vacuum filter. It covers a much wider range of applications than any other type. Therefore, its design and fabrication are the most fully developed. To depart from its selection, it's generally necessary to

justify more specialized equipment. This can be done on the basis of the few limitations inherent in the standard unit, or of the particular advantages of alternates.

As the most fully developed continuous unit, the standard drum filter has more refinements in design and more available accessory equipment for improved and special operation. It is also available in almost all commercial materials of construction in-

cluding wood.

Limitations—One limitation of the standard drum is its inability to handle very fast settling slurries which cannot be kept in suspension in the filter tank. It is difficult, also, to hold cakes formed from such slurries on the drum by vacuum. Specialized filters are also capable of discharging thinner cakes, of providing sharper filtratewash separations, and of utilizing countercurrent washing which the standard drum filter cannot effectively do. Also, displacement wash cannot be applied as easily as on the horizontal types. Fig. 1 shows a typical arrangement of a standard drum filter and auxiliaries.

Maintenance of continuous vacuum drum filters is usually quite low as compared to other process equipment. Better selection of materials of construction has done a lot in the last few years to eliminate corrosion as a source of high maintenance costs. The major maintenance item at present is generally cloth changing. Cloth life ranges from a week or so in the case of rapid blinding to many months. Even longer life can be achieved where wire screen cloth can be used.

Filter Costs—The cost curve shows uninstalled costs and available sizes of standard drum filter units. Auxiliary equipment usually runs about 25-40% of the base filter cost. A general rule of thumb for high spot estimates is: the total installed cost of a filter station is about twice the cost of filter

plus auxiliaries. This is for installation in an existing building.

#### Single Compartment Rotary Drum

This filter, like the standard drum, rotates about a horizontal axis, and is suspended in the slurry contained by the filter tank. Agitation of the slurry, however, is by recirculation of feed rather than by mechanical means. Specially designed tanks make this agitation effective on fairly fast settling solids. Fig. 5a shows this type of filter.

A distinguishing feature is the perforated drum, divided into a large number (90, as compared to the standard drum 12-24) of narrow longitudinal sections separated by division strips. Fig. 5b shows a detail of the exterior drum drainage deck flattened out for the purpose of illustration. Between the division strips are snap-in drainage plates made of punched metal supporting the filter medium. Rods lock the filter medium securely in the division strips.

Fig. 5c shows the interior of the drum and illustrates another principal difference between this filter and conventional drum filters: it has no internal sectional piping, the entire interior is subjected to operating vacuum. All the internal parts shown are stationary and rigidly attached to a rugged center pipe, commonly called the center girt of the filter.

The shoe or blowback valve is fitted with very close clearance to the accurately machined inside surface of the drum. This shoe has a narrow longitudinal slot at its sliding surface,

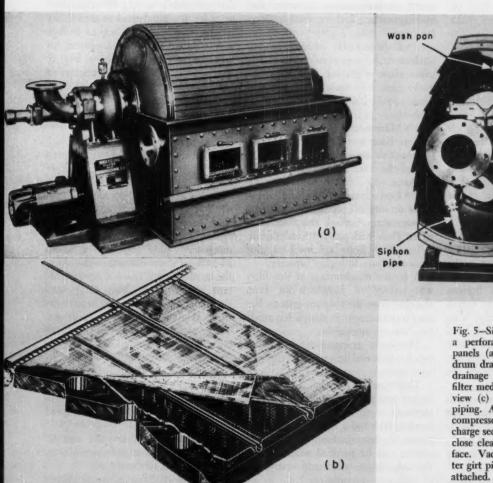


Fig. 5-Single compartment drum filter has a perforated drum divided into narrow panels (a). A flattened out view of the drum drainage deck (b) shows the snap-in drainage plates, and rods which hold the filter medium in place. The interior drum view (c) shows that there is no internal piping. A blowback valve brings pulsating compressed air to the drum at the cake discharge section. This valve rides with a very close clearance along the inside drum surface. Vacuum is applied through the center girt pipe, to which all internal parts are attached. Almost any material of construction can be used, except wood. (The Bird-Young Filter, Bird Machine Co.)

valve

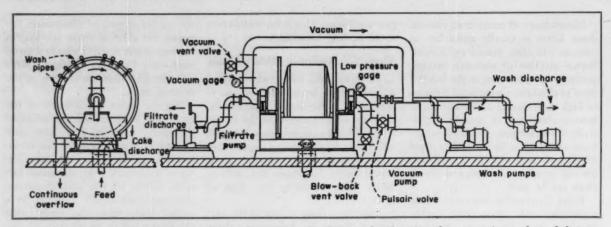


Fig. 6—Piping arrangement for single compartment drum filter. On this type of equipment, a sharp separation can be made between primary and wash filtrates. A pulsating air blowback removes thin cakes. (Bird Machine Co.)

communicating with the center girt and extending the full length of the

Shoe Is Important-The shoe performs three functions: (1) it shuts off vacuum from the drum sections at the point of cake discharge; (2) it conveys the pulsating blowback air from the center girt to the underside of the filter medium; and (3) it permits variable drum submergence in the slurry, depending upon circumferential length and position.

The primary filtrate and wash which collects at the bottom of the drum is removed by means of a self-priming pump through a dip tube or syphon pipe. This pipe continues through the center girt to the suction of the pump. Also, vacuum is applied to the drum through the center girt.

When separation of primary and wash filtrate is required, a close fitting wash collection pan is provided in the upper half of the drum. The wash filtrate is removed from a bottom trough on the collection pan by means of a second self-priming pump. Vacuum is supplied to the wash pan through properly designed underside louvers. In case of 2-stage countercurrent washing, two pans must be used.

In general the same methods available for controlling the standard drum filter are used for the single compartment drum.

The important advantages of this filter are:

· High capacity per unit area. Very thin cakes can be discharged,

and the filter can be run at high drum speeds.

· Sharp primary and wash filtrate separation is possible. This is due to direct communication between the filtering surface and the wash collect-

· Excellent cake washing. Higher washing capacity is possible since thin cakes allow a greater throughput of wash. Also, less wash liquor is sometimes required due to countercurrent washing.

· Minimum filter cloth blinding. This is because of the direct, strong blowback of air applied to the underside of the filter medium during cake discharge.

· Low internal pressure drop. Since no internal piping is present the pressure drop through the filter itself is less than with conventional drums. Where high flows are involved, this can contribute to higher capacity.

A former disadvantage of this filter was leakage of blowback air from the shoe into the vacuum system. Recent improvement in design has made this leakage negligible.

The single compartment drum filter can be obtained in most materials of construction, except wood.

This type of filter has an inherent higher cost per unit filtering area over standard drums-it requires sturdy construction and a high degree of precision in manufacture. Its use, of course, can be justified when any of the advantages previously stated are of sufficient importance.

gree of flexibility with this unit. It is impossible to provide one level of vacuum for cake pick-up and another for wash. For handling a different slurry of widely varying filtration characteristic the filter must be shut down for alterations to the shoe to change submergence. Typical arrangement for this type of filter is shown in Fig. 6. The filter is available in diameters of 1 to 5½ ft., lengths of 4 in. to 8 ft. and filtering areas of 1 to 135 sq. ft.

#### Dorrco Drum

The Dorrco is a drum filter with the filtering surface arranged in panels on the inside of the drum. One drum head is completely closed and the other has a concentric opening through which the slurry feeds and the cake discharges. The diameter of this opening determines maximum submergence. This generally is about 25-30% of drum diameter—the slurry lies in the drum, there is no separate tank. The opening size, along with the length of the drum, determines the maximum slope of the cake discharge chute. Where a relatively long drum is most economical, it may be necessary to substitute a belt or screw conveyor for the chute.

The drum is supported by a pair of flanged rollers and circumferential tires at each end, rotated by a variable speed

The automatic filter valve and filtrate piping are arranged externally on the closed end of the drum.

Normally bridging in the automatic There is some limitation also in de- valve is set so that pick-up begins just

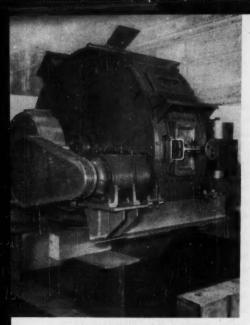


Fig. 7-A top feed filter is actually two units in one. (Swenson Evaporator Co.)

ahead of bottom dead center. This permits a classified cake to form.

Along with the horizontal filters this unit is effective on slurries containing a fraction of very coarse, fast settling material and another of fines or slimes. In this case, the coarse material will settle out first so that the formed cake is classified with the coarse fraction at the bottom. The fine fraction is deposited on top, thus minimizing cloth blinding. Where the slimes are of no value or are a contaminant, the Dorreo is sometimes allowed to overflow continuously.

Cake discharge is accomplished by gravity; vacuum shuts off slightly past top center. The discharge is often assisted by an alterating gentle blow and vacuum through a pulsating valve.

An Inexpensive Filter—The Dorrco is inherently inexpensive because of simplicity in design and construction.

Its major application has been on fast settling, fast filtering slurries which form easily dischargeable cakes having little blinding tendency.

Only a modest amount of wash can be used. Effective filtering area is limited because of the unused surface between cake discharge and the beginning of cake formation. However, this area can be used sometimes for cloth cleaning.

The filter can be built of most ordinary materials of construction. Maintenance is low again because of simplicity of design. The filter is available in diameters of 4 to 14 ft., lengths from 1½ to 18 ft., areas from 18 to 783 sq. ft.

#### Hopper Dewaterer

The hopper dewaterer is a drum filter with the filtering surface divided into panels—each of which has 6-in. or more deep retaining sides. Each panel therefore is a hopper.

Passage from the filtering surface to the automatic valve is by fabricated conveying channels or large piping from each section. This minimizes internal pressure drop for the large volumes of air required.

The slurry feeds just before top center into a hopper. Vacuum is applied for dewatering and drying after a short leveling and settling period. Vacuum usually shuts off for gravity cake discharge, as the hopper approaches bottom center. Blowback to assist cake discharge is seldom required.

The hopper dewaterer was developed for extremely fast draining and fast settling solids which cannot be handled on conventional drum filters. It will handle more porous cakes than the Dorrco, since gravity helps hold the cake on the drum until the hopper reaches the horizontal centerline.

The hopper dewaterer is relatively inexpensive because of simplicity in design and fabrication.

This filter is generally limited to simple drainage (with the assistance of low vacuum) of coarse solids where minimum cake moisture is not important. Only a modest amount of wash can be applied. The effective area is limited to less than 50% of total surface.

The filter is available in diameters of 3½ to 11½ ft., lengths from 1 to 10 ft., areas from 11 to 330 sq. ft.

#### Top Feed Drum

This filter (Fig. 7) is arranged similarly to the standard drum filter. However, there is no bottom slurry tank. Instead, slurry feeds to a distributor type feed box located above the filter, about 40° before top center. The slurry flows onto the drum from a riffleboard in the feed box and is confined between end flanges on the drum and flexible seals on the feed box. The formed cake passes through dewatering and drying zones to the discharge plow located about 10° before the feed box.

Most of these units are used as

combination filter-dryers and, therefore, are totally enclosed. The bottom portion of this enclosure acts as a hopper for discharged cake and is sealed to a screw conveyor or by a star valve. Hot air is blown at a slight positive pressure into the hood. Then it's drawn through the cake by means of a positive displacement or centrifugal type vacuum exhauster connected to the automatic filter valve. Instead of internal piping, large converging channels are used to convey air and filtrate, with little pressure drop from the filtering surface to the automatic valve.

Filter-dryers are usually equipped with multiple plows set at decreasing distances from the drum to remove the progressively drying cake. This permits greater quantities of air to be drawn through the wet cake.

Major Advantages—The major control of this unit is by means of a variable speed drum drive. It is a combination filter-dryer, and this is its major advantage. It will handle very fast settling materials, which a standard drum will not. Very often there is less crystal breakage than with conventional rotary kiln-type dryers.

The filter handles coarse, or free filtering crystalline solids very nicely. To prevent screen blinding in a filtering-drying operation of this kind, it's necessary that the solids be soluble. Then the screen can be cleaned as needed between the point of cake discharge and the feed box.

Only a nominal wash can be applied to a top feed filter and wash separation is not practical.

Materials of construction are cast iron and steel, cast Ni-Resist or bronze and fabricated stainless steel or Monel.

Maintenance is low—comparable to that for a standard drum filter.

The filter is available in diameters from 3 to 6 ft., lengths of 1 to 6 ft, areas from 9 to 112 sq. ft.

#### Scroll Discharge Rotary Horizontal

Essentially, this filter is a rotating horizontal table divided into a number of sectors (Fig. 8). Each sector is a separate compartment. Vacuum is applied from the automatic valve concentrically located beneath the filter. The bottom of each compartment slopes toward the center of the filter. Drainage and vacuum are handled

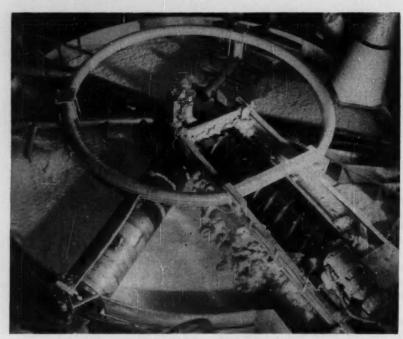


Fig. 8—Scroll discharge horizontal filter is divided into separate compartments, each connected to a central automatic vacuum valve. A filter tank is not required. The unit shown is handling chemical grade cellulose. (Dorr-Oliver, Inc.)

through a large port leading to the automatic valve. Filter medium is supported on a punched plate or wire mesh drainage deck and caulked into dovetailed grooves at the periphery of the sectors. An elevated center island and a circumferential vertical rim help to keep the slurry and wash liquors on the filtering surface.

Feed is applied by a pipe and a weir box distributor above the filter. Dewatered and washed cake is discharged by a spiral scroll located just ahead of the feed. A radial dam is placed between the scroll and the point of feed to prevent slurry running back to the cake discharging zone.

There is no filter tank. The unit is mainly controlled by rotational speed with a variable speed drive and by rate of slurry feed.

What Can It Do?—This filter has a number of advantages. It handles fast settling, and free filtering solids, at high rates and with relatively low capacity vacuum pumps. High cake washing efficiency is readily obtained, because the cake can be flooded with wash liquor. The same quantity of wash liquor applied to a drum filter would cause serious feed dilution.

Ability to apply the wash at the exact point just before the primary filtrate leaves the cake, results in a true displacement wash with a further increase in efficiency. The filter is well suited to relatively sharp separation of filtrates—this allows several stages of countercurrent cake washing. The filter also has a high cake capacity per unit of area since there is no idle

time between various parts of the filter cycle as there is on rotary drum vacuum filters.

Finally, the design eliminates a filter tank and agitator. Thus, there is no slurry hold-up during operation, no heel left at the end of a run, and no crystal degradation due to mechanical agitation.

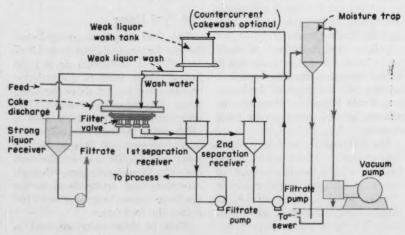
The scroll discharge filter is more expensive per unit area than conventional drum units and the hopper dewaterer or Dorreo. Therefore, it usually must be justified on the basis of advantages over other types or because of limitations of other filters.

Incomplete Cake Discharge-In a horizontal filter, the scroll does not completely discharge the cake. Clearance between the scroll and the filter medium is usually at least & in .which leaves a heel of cake. This cake recycle, in itself, reduces filter capacity somewhat. With some materials the wiping action of the scroll results in a compression or smearing of heel, making it difficult to dislodge and disperse in the incoming feed. This is true even with the usual blow-back air either before the feed point or in the feed section. Such a non-dispersable cake can limit capacity and continuity of

If the cake is dispersed with incoming feed, the residual wash liquor left in the heel results in slight dilution of strong filtrate. In some cases this can be detrimental if a very sharp wash separation is required.

The filter is usually limited to slur-

Fig. 9-Efficient countercurrent washing is one of the advantages of the scroll discharge horizontal filter. Sharp separation of washes is no problem. (Dorr-Oliver, Inc.)



ries from which at least a  $\frac{3}{4}$  in. cake can be formed in a reasonable period of time (around 30-60 seconds). This thickness is generally necessary for efficient scroll discharge.

Finally, greater floor space is required per unit area because the surface is spread out in a horizontal plane.

The filter is available in most metals and in rubber-covered construction. It can be built as a totally enclosed, vapor tight unit for use in hazardous service or where inert gas recirculation is required.

Fig. 9 shows a typical arrangement for this filter with countercurrent washing. Uninstalled costs are shown on the filter cost curve.

Maintenance is perhaps a little more difficult than with the conventional drum filter because of relative inaccessibility of the filter valve. However, this unit, in common with most continuous filters, is not considered to have high maintenance costs.

#### Tilting Pan Rotary Horizontal

Here is a comparatively recent contribution to the processing industries—the tilting pan rotary horizontal filter (Fig. 10).

There is an essential difference between this unit and the scroll discharge horizontal. Filter compartments are made up of independent pans with shrouds around the peripheries. This filter could be described simply as a series of vacuum nutsche filters or buchener funnels traveling in a circle, with a means of inverting the individual filters at the point of cake discharge.

Caulking supports and holds the cloth, in the same manner as on the scroll discharge horizontal. A roller riding on a track and encircling the filter, carries the pans.

The inner edge of each pan connects to a swivel pipe joint (or to a flexible connecting hose). This conducts the vapor and liquid to an independent vertical pipe leading to the automatic filter valve, centrally located beneath the filter.

Cake Discharge—The most important difference between this filter and the scroll horizontal is in the method of cake discharge. A mechanism inverts or tilts the pan to discharge the cake at the discharge point. The pan then returns to the original horizontal position.

One manufacturer provides a second but smaller automatic valve on the top center of the filter to assist in discharge of filter cake. This valve, and suitable instrumentation, makes it possible to maintain full vacuum on the discharging pan until it reaches the maximum inverted position. At this point vacuum cuts off, simultaneously with the application of a short duration snap blow.

The maintenance of vacuum on the discharging pan during the tilting period prevents cake from sliding across the filter medium. This reduces cloth abrasion.

In addition to the advantages of the scroll discharge filter, the tilting pan unit has other special advantages. The tilting pans, coupled with the snap blowback, produces more complete cake removal and reduces recycling of cake.

Also, the individually shrouded pans provide a positive method of confining the proper amount of wash liquor to a given amount of cake.

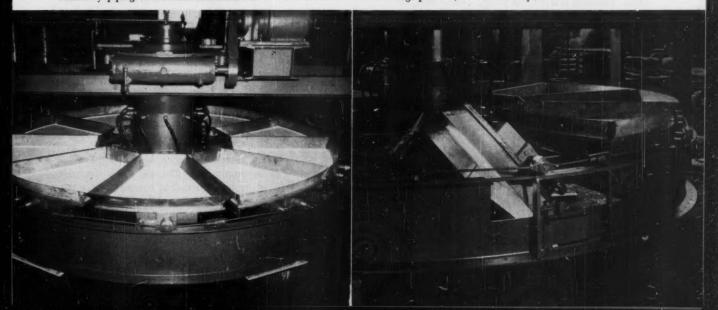
Again this unit is more expensive per unit area than conventional drum filters and must be justified, on the basis of its advantages, or limitations of other units.

How It's Used-The filter should generally be used on slurries which will form a ½ in. or thicker cake in about 30-60 seconds. Maximum speed is limited to about 1 rpm. because of the tilting pan mechanism. With some materials, this could limit capacity. For extremely high slurry feed and wash flows, more complicated multiple feeding arrangements for both slurry and wash liquors are 'necessary. In some cases there is a tendency for cake to cling to the pan shrouds, especially at the corners. This reduces effective area and requires additional attention by the operator. The unit requires greater floor space than conventional drum filters.

Typical arrangement for this filter is the same as for the scroll discharge horizontal. Uninstalled costs are shown on the cost curves.

There has not been a sufficient number of these units in operation, to give an indication of maintenance costs.

Fig. 10—Tilting pan horizontal filters are a variation of the scroll discharge. Here the filter is divided into independent pans connected by piping to a central automatic valve. Pans tilt at the cake discharge point. (The Eimco Corp.)



#### Belt or Traveling Pan

The original belt filter (Fig. 11) consists of an endless reinforced rubber belt with a filter cloth riding on top. Small drainage holes are arranged in the center of the belt. The belt passes over stationary suction boxes between two drums or pulleys used for driving and guiding the belt. Slurry feeds on top of the belt. Vacuum is applied through the suction boxes to dewater, wash and dry the cake

formed. Cake is discharged as it passes over the pulley at the end of the filtration cycle.

Latest Designs—Recent models (Fig. 12) have been introduced by various manufacturers. The belt still functions as the filter valve but not as the drainage deck or support for the filter cloth. A series of individual shrouded pans are attached to the top of the belt instead, and the individual cloth sections are attached to

these. The belt itself is therefore narrower and more rugged.

Potentially, at least, the belt filter has all the advantages of the scroll discharge and tilting pan horizontals. Washing of the filter cloth is conveniently done with the pans in the inverted position during the return to the start of the filtration cycle. A drip pan is provided underneath the filter to catch the wash liquid.

Idle time for each pan amounts to more than 50% of the cycle.

This type of filter is considerably more expensive than the other horizontal types. It is limited to materials in which some type of rubber will stand up.

The other limitations are similar to those for the tilting pan horizontal, except that there is no speed limitation due to method of cake discharge. And floor space requirement per unit of area effective are considerably greater than other horizontal types.

Typical arrangements for this unit are comparable to other horizontals. While maintenance costs have been decreased, it is likely that maintenance costs on any belt filter will be somewhat higher than for conventional drum and horizontal units because of belt wear and replacement. Sizes for these have not been fully standardized, but they will probably be offered in the same range as scroll discharge horizontals.

#### Vacuum Disk

The vacuum disk filter consists of a number of circular filter elements mounted on a rotating, horizontal, hollow shaft (Fig. 13). Each element, or disk, divides into a number of individual sectors having suitable drainage and filter medium supports. Vacuum is applied to each row of sectors. Filtrate and air are removed through radial pipe nipples which connect to a manifold. This manifold leads through a hollow shaft to the automatic valve.

Filter cloths take the form of bags which slip over the sectors. Outer edges are folded over and clamped. The disks rotate in a high submergence slurry tank (about 33% minimum). On the cake discharge side, each disk is contained in a narrow compartment forming an integral part of the slurry tank. The cake falls

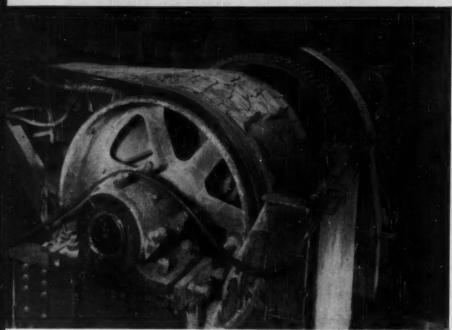
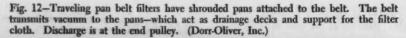
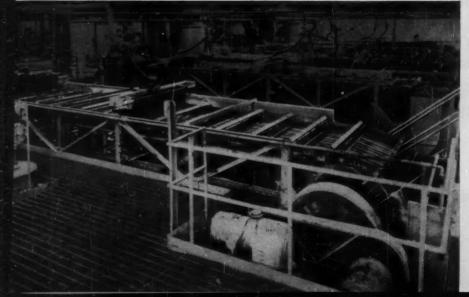


Fig. 11-Belt filters (Lurgi) handle a slurry on a horizontal, endless perforated rubber belt, fitted with filter cloth. Filtration and washing take place on the belt. Cake discharges over an end pulley. (Mercer-Robinson Co., Inc.)





in the space between successive compartments. A gentle blow is applied to inflate the bags—this discharges the cake. Scraper or rolls are also used.

Inexpensive, Compact—A vacuum disk filter is relatively inexpensive per square foot of filtering area, as compared to drum filters. It is compact, requiring less space per square foot. Individual sectors can be quickly, and easily replaced with spare units, in case of cloth failure.

Only a modest amount of wash can be applied, however, because of the vertical filtering surfaces. Another limitation of the standard disk, is that no agitation is provided in the filter tank. This can produce an uneven cake, resulting in high cake moisture, low capacity, short cloth life and poor discharge. However, disk filters are available with a paddle type agitator mounted in a V-bottom tank. This arrangement eliminates such difficulties.

The filters are generally made of wood, steel and bronze, but could be furnished in most other materials including stainless steel and rubber.

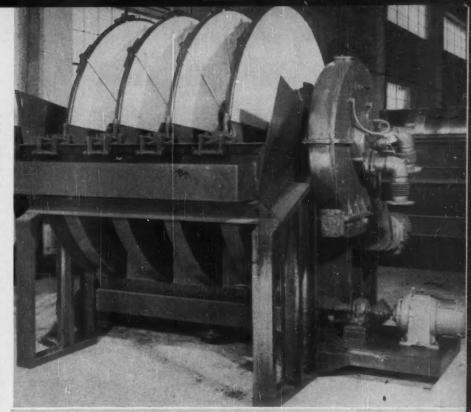
Typical arrangements and maintenance are similar to drum filters. The filter is available in diameters from 4 to 12½ ft., with up to 16 disks, and with areas as high as 2,400 sq. ft

#### Continuous Precoat Filters

The continuous precoat filter is a rotary drum filter, with a special method of solids discharge. A 2-3 in. bed of precoat is built into the filtering surface prior to filtration. During the filtration cycle, a thin layer of this precoat, along with the deposited solids, is continuously shaved off by an advancing knife edge. Therefore, no air blow is necessary for cake discharge. There usually is a paddle-type agitator in the filter tank.

The filter can be operated either as an open or vapor-tight vacuum unit, or as a pressure filter. It is not truly continuous, since it must be shut down intermittently to replenish the precoat material (usually diatomaceous earth). The cycle lasts from 8 hours to as much as 10 days, depending on the depth of precoat cut and drum speed.

Very thin cakes can be discharged from a precoat filter—cakes that ordinarily cannot be discharged from con-



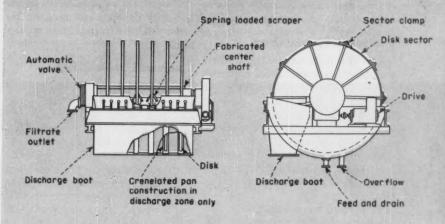


Fig. 13—Disk filters are relatively inexpensive, compared to a drum. The disks are arranged on a hollow, rotating horizontal shaft. Filter cloths are placed over these disks. (Top, the Eimco Corp., bottom, Dorr-Oliver, Inc.)

ventional filters. A major use is in solution clarification, where no appreciable cake forms or where a very thin cake is practically impervious. It can also be used in cake filtration, where the cake formed in a reasonable amount of time, is too thin to be discharged from other continuous filters.

The knife advancing mechanism is perfected to a point where a very thin shaving (0.001 in. or less) can be maintained continuously. The knife itself, consisting of 6 in. blade sections is self-sharpening and lasts a year or longer.

As with drum filters, maintenance costs are relatively low.

The filter is limited to low viscosity materials. And, of course, solids are contaminated with the precoat material

Common metals, alloys and rubberlined steel are available as materials of construction for precoat filters.

Vacuum precoat filters can be obtained in the same size range as conventional drum units. Pressure precoats are limited to around 165 sq. ft. maximum.

#### Continuous Pressure Filters

While they are not as widely used as the vacuum counterpart, continu-

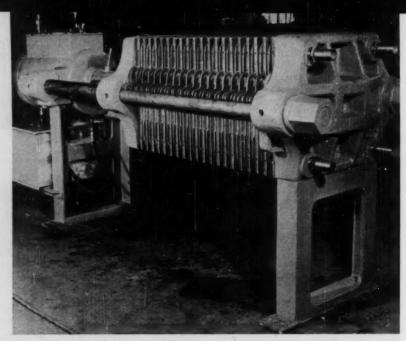


Fig. 14-An assembled plate-and-frame filter press, with closed channel delivery. This is a 24-in. press, of stainless steel construction, with an hydraulic closing device. Used for filtering pharmaceuticals. (D. R. Sperry & Co.)

ous pressure filters have very definite and important applications.

#### Continuous Pressure Drum

This filter is the same as the vacuum multiple-compartment drum units except that it's provided with a pressure tight closure. This permits pressure from the outside of the cake to be used as the motivating force of filtration, instead of vacuum from underneath the cake. It is essentially equivalent to its vacuum counterpart, in performance, advantages, and limitations.

However, it has a further important advantage of higher capacity per unit of area, especially for relatively noncompressible cakes. This could be particularly significant where expensive construction materials are required and the smallest possible filter is desired. In most cases, however, cost is higher than for a vacuum unit, since a pressure tight enclosure is required. Sometimes, when some other consideration requires a vapor tight enclosure, it's better to use pressure instead of vacuum because of the increased filtration rates.

A major complication comes up when a dry cake discharge is required. Removing dry cake involves the use of rather elaborate dual pressure locks (or other sealed discharge mechanisms) to prevent loss of pressure. The practical limitation on pressure for this type of filter is around 30-40 psi.

Maintenance is somewhat higher than with the open vacuum drum because of relative inaccessibility of parts in the unit.

#### Continuous Pressure Disk

A pressure-tight enclosure around the rotary disk filter allows it to be used as a pressure unit.

This filter again has the same advantages and limitations as the vacuum counterpart, although again increased rates with pressure must be considered. It is often more economical than the pressure drum when wash requirements are low. It is normally not built for more than 30-40 psig. working pressure. Dry cake discharge adds complications.

A typical arrangement and maintenance would be comparable to the pressure drum unit.

The filter is available with the same size disks as the vacuum counterpart, but requirements of a pressure enclosure limit the filtration area to 200-400 sq. ft.

#### Batch Vacuum Filters

There are two main types of batch vacuum filters. One is the batch leaf, the other is the batch nutsche—both have relatively low first costs.

#### Batch Leaf

The Moore filter is a good example of a batch vacuum filter. It consists

of a number of rectangular leaves on frames, over which filter cloths are stretched. These frames are made with suitable drainage members, and each frame has a top filtrate outlet. A number of leaves manifolded together are submerged in a tank containing slurry.

Filtrate draws through the cloth when vacuum is applied, and the cake deposits on the outside. The leaves are then lifted out of the filter tank with a crane, and placed in a wash tank. Vacuum is maintained during this transfer by means of flexible hoses. Wash liquor draws through the cake in the same manner. The leaves are then transferred to a dump tank, where an air blow discharges the cake.

This filter has been used on very high tonnage production jobs, where strong filtrate recovery is vital, and where there are highly corrosive conditions. The Moore filter has a very low first cost and takes up little floor space per square foot. However, continuous filtration is gradually supplanting this type of operation.

During transfer of the leaves, care must be taken, so that cake does not drop off. If this happens, poor washing results, due to short-circuiting.

#### Batch Nutsche

Nutsches are the simplest of filters, consisting of a tank with a false bottom for drainage, and a support for filter medium. They can be operated by gravity, vacuum or pressure. A major field of application is in low scale, or pilot plant production rates, on free filtering materials. Nutsches are simple and inexpensive. They can be fabricated of any necessary material.

Considerable labor is usually involved in recovering a dry cake, but these filters are available mounted for tilting to effect cake removal. Also, they have been built with agitators, so a cake can be reslurried by means of backwash.

#### **Batch Pressure Filters**

Under this important group, we will discuss plate-and-frame, pressure leaf and clarification type filters.

# Plate-and-Frame Filter Press

The filter press has been the best known and perhaps the most widely used of all batch pressure filters (Figs. 14 and 15). It's been completely covered in the literature, particularly in excellent manufacturers' catalogs (Shriver and Sperry) which explain operating principles of the various available types. Special designs for most effective washing, dryest cake, fast settling solids, etc., are explained.

The filter press occupies less floor space per unit area than any other filter. It is the least expensive per unit area if cast iron or wooden construction is employed. But it can be made of any construction material. A very versatile unit, it's used on materials with widely varying filtration characteristics. With high pressures, viscous solutions can be handled satisfactorily. However, a relatively high labor cost is involved for discharging and cleaning. Sealing is a serious problem on toxic or volatile liquids.

Recent Design—A most recent development is mechanized plate-and-frame filter. (Fig. 16).

Circular plates are fixed in a vertical position, and supported at the centerline by a horizontal shaft on each side of the filter.

Two sets of circular frames (about 2 in. thick) mounted 180° apart are attached to one of the side shafts, which can be rotated. When one set is in the operating position, the other is in the cleaning or discharge position.

The plates are made up as two movable parts sealed to each other by O-rings. Between them, they form a closed compartment. For closing and sealing the filter, air pressure (15 lb.) in excess of operating pressure is applied to this compartment, spreading the two parts against the adjacent gasketed frames.

This closing pressure is maintained throughout the filter cycle. Operation is about the same as any standard filter press, except that the frames must not be completely filled; at least a ½ in space must remain between the cakes formed in each frame.

Washing and blowing, if required, is done through the feed connection.

New Method for Cake Discharge— The principal innovation of this filter lies in the manner of cake discharge. For this part of the operating cycle low air pressure is applied through the filtrate outlet. This bulges the



Fig. 15—Each plate-and-frame forms a chamber—the cloth held between the plate and the frame. After the chambers are closed, slurry is pumped in. Flow is to all chambers simultaneously. (T. Shriver & Co., Inc.)

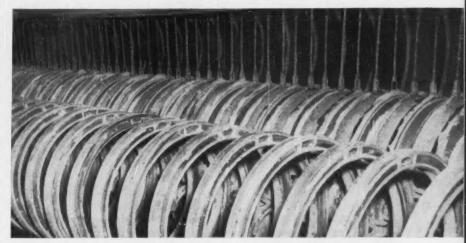


Fig. 16—A modification of plate-and-frame filter. Paired sets of frames are mounted 180° apart on a central shaft. One set is always in operation, while the other is in a cleaning position. Filter shown has 30 paired frames. (The Eimco Corp.)

filter cloths and pushes the cakes together in the center of each frame. The sealing pressure is then relieved and vacuum applied to the inner compartment between the two halves of each plate. This vacuum draws the two halves together and provides clearance between the plates and frames so that the filled frames can be rotated to the unloading position while the

clean set moves into the operating position.

A relatively small number of these filters have been placed in operation, so no data are available on maintenance costs. However, it appears that the filter should have a high capacity, low labor costs, and long cloth life. It's a complicated piece of equipment, however, and expensive to purchase.

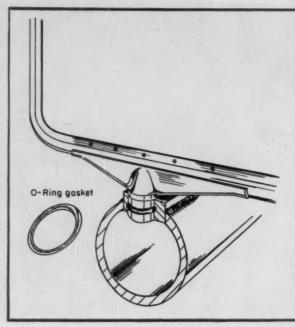




Fig. 17—Leaves, on batch pressure vertical leaf filters, are attached to a manifold and sealed with an O-ring (Niagara Filter Corp.). One type of pressure leaf filter takes the form of a vertical tank. (Process Filters, Inc.)

It can be justified only after an evaluation of all factors: labor saving, capacity, capital investment, etc.

#### Batch Pressure Vertical Leaf

Vertical pressure leaf filters consist of a series of uniformly spaced vertical leaves mounted in a cylindrical pressure vessel.

The older types such as the Kelly, Sweetland, Vallez, etc., are well known and have been fully described in Perry. In recent years the tendency has been away from such types and toward simpler, less expensive fabricated tank construction. This discussion will be limited to this newer type, offered in a variety of designs by a large number of manufacturers.

Fabricated Tank Filters—There are many variations in the shape and size of the leaves as used in these filters—depending upon whether the tank is mounted vertically or horizontally.

In general, the leaves consist of a heavy (4-5 mesh) wire drainage screen mounted in a tubular frame, which acts as a support and filtrate conduit.

Filter medium may be either fine mesh wire cloth or any natural or synthetic fabric. When wire cloth is used (usually a dutch weave for greater durability) one piece is installed directly on each side of the drainage screen. The wire cloth is sealed between flanges on the frame by rivets, bolts, or sometimes soldering or welding. When a textile fabric is desired two 4-5 mesh drainage screens are used; or a single drainage screen with another lighter (8-10 mesh) cloth backing screen on each side.

Usually the leaves are assembled on an internal bottom manifold. The seal between leaf and manifold can be by O-rings, tapered ground joints, etc. (Fig. 17).

In some cases, with vertical tank filters, individual leaf outlets are carried through the tank shell before manifolding. This permits the use of sight glasses and shut-off valves for detection of cloudy filtrate and shut-off of any defective leaf.

Two Types Are Available—Cylindrical tanks used for this filter, come in two types. One in a vertical position, and the other in a horizontal position. Either type can be used for dry cake discharge or sluice discharge. In general, the vertical tank is the best choice when cake sluicing is employed; the horizontal tank is primarily limited to dry cake discharge.

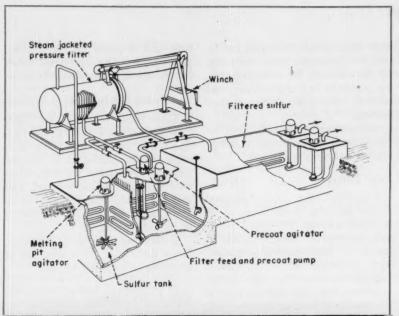
However, the vertical tank can be equipped with a quick opening cleanout door below the leaves, or with a quick opening bottom head. Both allow for dry cake removal.

One manufacturer of the horizontal type uses a top manifold with special bottom drainage leaves. This design simplifies cake discharge by eliminating interference of the manifold with cake removal.

These filters are all equipped with quick opening heads—swing bolts and hand wheels or a special bayonet type closure. Hydraulic or mechanical devices are used to move the heads.

On the horizontal type the leaf and manifold assembly is attached to the movable head (Fig. 18). Leaves and head are removed from the filter, for discharging and cleaning, by internal rollers and a monorail. A recent innovation is use of an internal O-ring for the filtrate manifold. This allows the head and leads to be removed without externally disconnecting the head filtrate piping. In this case the filtrate connection is made through the nonmoveable head of the filter.

Washing Methods—Sluicing devices for vertical tank filters are of two types. One is a fixed header with three nozzles between each pair of leaves. The other is an oscillating header with a single nozzle between each pair.



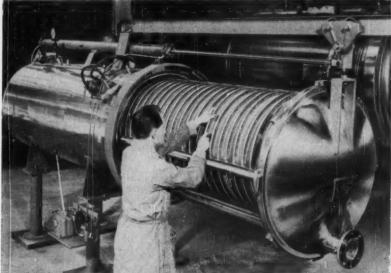


Fig. 18—Piping arrangement for a horizontal tank pressure leaf filter, shown handling molten sulfur. (Bird Machine Co.) The leaf and manifold assembly are removed on a monorail, as shown in the photograph. (Niagara Filter Corp.)

Both provide satisfactory coverage of the leaves. The oscillating type can be manually or motor operated.

For effective sluicing, with the stationary set-up, about 3 gpm. of sluicing liquid per nozzle, at 50-75 psi. is required. One special design, of the horizontal type, incorporates circular leaves rotating on a center shaft—which also serves as the filtrate manifold. The advantages of this particular unit are more uniform cake formation, more effective sluicing, and reduced filter medium blinding.

Advantages and Disadvantages—Vertical leaf filters are used for the same types of applications as filter presses. Usually leaf filters made of mild steel, have a greater cost per square foot of area, compared to cast iron or wood presses. If special materials of construction are needed, the leaf filter is often no more expensive than a press. Lower labor costs, more effective cake sluicing, easier and quicker dry cake removal, or larger capacity (less restricted filtrate drainage) can sometimes com-

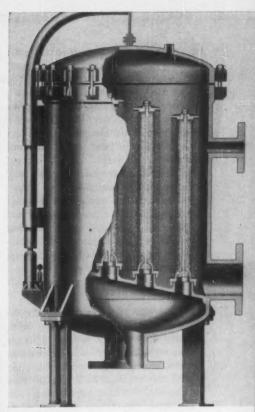
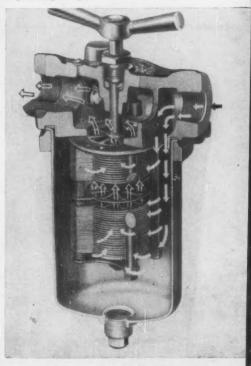


Fig. 19-Rigid elements of porous stone or carbon, are important features of this filter. (R. P. Adams Co., Inc.)

Fig. 20—Edge filters have stacked metal strips separated by metal spacers. (Cuno Engineering Corp.)



pensate for the higher initial cost. Leaf filters can easily be jacketed, compared to filter presses. Since the filter tank is a pressure tight vessel, there is less of a leakage problem, especially with hazardous materials. Maintenance is low, and the filters are available in most metals and rubber-lined steel.

Leaf filters are generally not built for operating pressures above 75 psi.—compared to several hundred for presses. Certain types of filter media (paper, bulk cotton) cannot be used with a leaf filter. Uninstalled cost information and available areas are given on the cost curves.

#### **Tubular Element**

This type of filter is essentially the same as vertical leaf pressure units, except that hollow tubular elements (porous carbon, porous stone, sintered metal, screen-wrapped perforated pipe, etc.) are mounted in a pressure tank (Fig. 19). The unit is considered competitive to the vertical leaf filter when a dry cake discharge is not required.

A major advantage to this type of filter, over vertical leaf, is that a rela-

tively high pressure backwash can be used for discharging cake, and cleaning the elements. On some materials, this proves to be a more effective and efficient means of discharge than sluicing.

Maintenance is generally low, although with porous stone or carbon tubes, breakage is a problem.

#### **Edge Filters**

Edge filters (Fig. 20) are designed to trap particles in the range of 90 to 1,500 microns. The liquid passes between strips of metal, separated by spacers of predetermined thickness. Most models can be cleaned, without stopping the flow. This filter is used to remove relatively small amounts of contaminating particles from a liquid. A modified design allows for separation of 40-micron particles.

#### Cartridge Filters

Cartridge filters (Fig. 21) can handle particles in the 5 to 100 micron range. They are useful for the removal of low concentrations of dirt and agglomerate particles from a liquid. Usually, the filter element is replace-

able, and is made of fiber, fabric, paper, porous ceramics, porous metals and plastics, and electroformed screens.

## Horizontal Batch Plate

These filters (Fig. 22) are essentially multiple-deck nutsches. As such they can be used for the same type of small scale production service on cake filtration. Pressure is not required to hold the cake, which rests on horizontal supports. This allows for uninterrupted service without the danger of the cake falling off.

With a precoat, or light filter paper, batch horizontals do a nice job of clarifying or "polishing" liquids.

#### Filter Accessories

An arbitrary distinction is made here between accessories and auxiliaries. Accessory equipment is considered to be something installed on the filter itself. Auxiliary equipment is separate machinery such as pumps.

A convenient way of discussing accessories is to classify them according to the problems they are intended to solve.

Fig. 21—Cartridge filters remove contaminants from liquid streams. Cartridge is removable. (Dollinger Corp.)

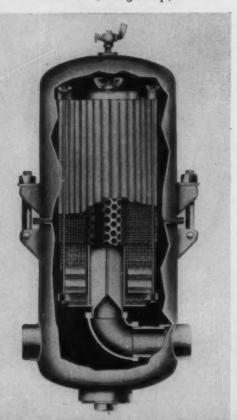
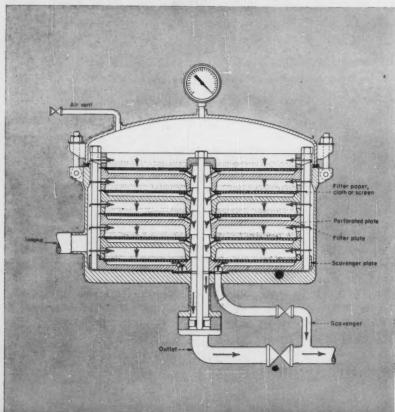


Fig. 22—Horizontal plate filters are useful in clarification filtration. Flow is downward; the cake builds up on the filter medium, which rests on a plate. A scavenger plate permits more complete recovery. (Sparkler Manufacturing Co.)



#### Wash Distribution and Efficiency

The standard means of applying a wash on continuous filters is either by spray nozzles or drip pipes. Both are subject to plugging-resulting in poor distribution and efficiency. Elaborate strainer or cartridge filter systems are often used to combat this condition. An alternate device is shown in Fig. 23a. It consists of a weir box with a series of small v-notches. This particular one was designed for a rotary horizontal filter with the notches spaced in such a way as to give distribution proportional to the wash area. These notches have very little tendency to plug. In many cases such wash boxes give trouble-free operation on both horizontal and drum filters.

Two other accessories are a drag blanket and a traveling blanket. They help in even wash distribution and also in washing efficiency by allowing a greater degree of washing. Fig. 23c shows that the drag blanket is attached at the back of a drum filter so that cake is dragged under it. The wash is applied on the top of the blanket where it tends to be held in longer contact with the cake. With some ma-

terials as much as 20% more wash will go through the cake, without allowing excess to run off into the filter tank.

The more complicated traveling blanket, shown in Fig. 23b moves with the cake and over a system of rolls. On some materials more than 50% greater amount of wash can be applied without run off, compared to a drag blanket.

#### Cake Cracking and Cake Dryness

Two problems related to wash distribution and efficiency are cake cracking and cake dryness. Both drag blankets and traveling blankets are helpful in preventing cracking and in healing cracks already formed.

There are also several operating tricks which tend to reduce cake cracking. One is to operate with as thin a cake as possible—thin cakes, of a given material, generally crack less than thick cakes. Another is to keep the cake wet by means of sprays as it emerges from the slurry. Still another is to reduce the solids content of the slurry from which the cake forms. Usually a denser cake with less crack-

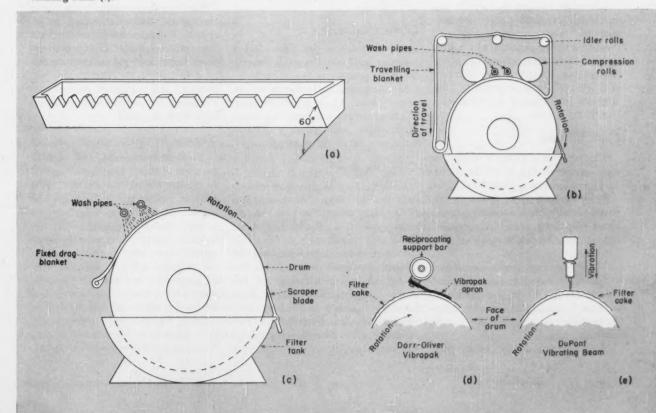
ing tendency will be formed from a more dilute slurry. This can be accomplished by means of recycling filtrate back to the feed slurry. However, this results in some sacrifice in filter capacity.

The problem of maximum cake dryness occurs often both in existing and proposed installations. The two best methods available now for getting cakes with less moisture than represented by the equilibrium moisture content, after a reasonable period of air drying are: (1) compression rolls and (2) vibrating devices.

Compression rolls (either solid one piece rolls or a series of disks) are mounted across the face of a drum filter. These rolls are used where simple compression will squeeze additional moisture out of a cake.

In practice the traveling blanket is generally used only with compression rolls. However, the rolls can be run without a blanket. It is often better to drive the rolls independently a little faster than the drum. Where washing is being used it often pays to use two rolls; one before washing to squeeze as much primary filtrate as

Fig. 23—Filter accessories. For improved washing, there is a wash distribution device that does not plug (a), a travelling blanket (b) and a drag blanket (c). To eliminate cake cracking, there are vibrating devices—Dorr-Oliver Vibropak (d) and the DuPont vibrating beam (e).



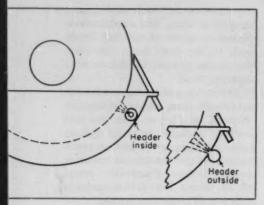


Fig. 24-A cloth-cleaning shower can be useful in reducing cloth blinding. A header, outside the tank, is recommended.

possible out before applying the wash, and the other after washing to get the dryest possible cake.

Vibrating devices are used on cakes which require a puddling action, or an actual change in structure before additional separation can be made. Dorr-Oliver has a patent on the Vibropak shown in (Fig. 23d). The vibration is longitudinal across the face of the filter. The DuPont company has patented a vibrating beam shown in Fig. 23e. Its vibration is in a plane perpendicular to the filter cake.

Laboratory leaf tests will usually predict fairly accurately the order-of-magnitude improvement possible with these methods. On cakes which lend themselves to compression the solids content can sometimes be increased over 50%, while those requiring pudling can be increased in solids content 10% or more.

# Cloth Blinding

This problem is probably present to some extent in almost all filtrations. And is serious in a great many.

Filter medium selection is very important where cloth blinding occurs. Usually at least some improvement can be made by selection of a different cloth.

There are two major accessories available for reducing cloth blinding on continuous filters: (1) a submerged blow-back connection on the automatic filter valve and (2) a cloth cleaning shower.

The submerged blow-back (pat-

ented by Dorr-Oliver) consists of an extra connection with proper bridging in the filter valve to apply a blow-back similar to that used for cake discharge. On a drum filter this blow-back is applied as each section becomes fully submerged in the slurry, after passing the scraper blade.

This feature is even more important on a scroll discharge horizontal filter than on a drum. The residual heel left on this filter has been described. A dry blow-back to break up this heel is often ineffective. The residual rides around, becoming more and more impervious, reducing filter capacity. If the blow is applied under submergence at the slurry feed, however, the heel will often disintegrate readily and mix with the incoming feed.

A cloth cleaning shower installed underneath the scraper blade on a drum filter is a simple but effective accessory. It can make the difference between an operational headache and a smoothly running filter. It is important to design the shower and the filter tank itself in such a way as to prevent cake build-up under the scraper blade. A good design is shown in Fig. (24), with the header outside and the nozzles flush with the tank. A combination dissolving and scrubbing action is best, but with insoluble solids the scrubbing alone is often very effective.

#### Liquor Confinement

An advantage of pan filters (either rotary or belt) over the scroll horizontal is the positive means of confining feed slurry and wash liquids to the proper places. However, development of efficient dams has made it possible to approach such effective confinement on scroll discharge filters.

#### Cake Discharge

Cake discharge is an important consideration in many continuous filtrations. Many accessories have been devised just for this purpose. In fact one drum unit considered a distinct type—the string-discharge filter—was developed specifically for thin cake discharge. A major advantage of the single compartment vacuum drum filter is its ability to discharge very thin cakes. Also, the panel-type conventional drum filter is designed for this purpose.

In addition such devices, as the wire discharge, where a wire is used in place of a floating scraper blade are utilized for improved cake discharge in certain cases.

A great variety of rolls (such as the Couch roll) are available for special cake discharging problems.

#### Filter Auxiliaries

#### Filtrate Receivers

Filtrate receivers are actually separating devices. They are used for separation of gas and filtrate during the operation of vacuum filters, and in some cases for pressure filters. All continuous vacuum filters with the exception of the single compartment type require separators.

For normal operations, the separator may be of simple design. A single tank with the mixture of liquid and gas entering a side nozzle, and gas discharging at a nozzle in the upper head, is usually quite satisfactory.

A somewhat improved design uses a tangential entry with gas discharge through a vortex finder. Filtrate in all cases is pumped from a nozzle at the bottom of the receiver. Baffles of various designs are sometimes used to break up the vortex and prevent pump cavitation.

Cyclones designed for heavy liquid loading are occasionally used as receivers. Cyclones have the disadvantage of inadequate filtrate hold-up. Since the centrifugal pumps normally used to handle the filtrate may momentarily lose their prime on occasion, a reasonable amount of filtrate hold-up capacity is advisable.

#### Vacuum Pumps

Two general classes of vacuum pump operation have been applied to vacuum filters—wet and dry. Wet vacuum pumps handle both gas and liquids. If separation is necessary, it is performed following the discharge from the pump. Wet vacuum pump operation is not frequently used in the chemical industry, since the overall economics are generally unfavorable. And in many cases wet vacuum pump operation is completely impractical. Dry vacuum pump operation requires a separation of gases from liquids at operating vacuum, fol-

lowing which the gases are compressed for removal from the system.

An example is the Nash vacuum pump. This pump operates with a liquid seal. The pump may be jacketed and a small flow of cooling water is normally injected into the inlet for control of temperature and maintenance of sealing liquid at the required level. This equipment is readily adaptable to wet or dry operation where operating vacuum above 18-22 in. of mercury is not required. For higher vacuum, other types of pumps may be more economical.

The double rotor, cycloidal type of pump is also used. This pump can be operated completely dry but it is more efficient if a small quantity of sealing liquid is injected into its suction. It is best adapted to dry operation but will handle small quantities of liquid satisfactorily. Usually it is the most economical over-all of all mechanical pumps. It is relatively efficient at all operating vacuums up to 20 in. of mercury. When properly operated maintenance costs are very low. It is applicable in essentially all cases except where very corrosive conditions are encountered.

Steam jet ejectors are usually selected for application where extremely corrosive materials are to be handled. Since ejectors have no moving parts they can be constructed from almost all classes of materials. For operations where mechanical pumps can be applied, the economics of ejectors is almost always unfavorable, except in cases where steam costs are exceptionally low.

Reciprocating vacuum pumps are quite widely used. But this type of equipment is currently losing ground to the more simple rotary equipment. However, where operating vacuum exceeds 22 to 24 in. of mercury, reciprocating equipment may represent the best economics.

### Scrubbers

In either vacuum or pressure operation it is occasionally necessary to remove corrosive or toxic materials from the gas streams involved. Standard types of absorption equipment are normally utilized for these operations—packed columns, plate columns, etc. Where process conditions permit, a water-ejector fume scrubber may be

used as a combination scrubber and vacuum pump.

### Condensers

Where liquids are filtered at temperatures near their flash point, large quantities of vapors may be discharged in the gas streams leaving the filter. In these cases, condensers may be required for recovery of valuable solvents, for improving the efficiency of vacuum pumps, or for other reasons.

Designs vary widely. Shell and tube heat exchangers are common for recovery of valuable solvents. Where water vapor is condensed to improve efficiency of vacuum equipment or for other reasons various types of gasliquid contactors may be employed. Again, the ejector type of fume scrubber may sometimes be advantageously used as both vacuum pump and condenser.

### **Entrainment Separators**

Where highly efficient separation of liquid from gas streams is a requirement entrainment separators become important. This separation equipment may be built into the filtrate receiver, or it may represent an independent piece of equipment. In the majority of cases separation efficiency is a function of pressure drop. Consequently, it increases the size and power requirements of vacuum equipment. Satisfactory separators include cyclones, other centrifugal equipment, and impingement devices.

Where appreciable pressure drop cannot be tolerated, screen mesh or packed fiber section can often be efficiently applied. These devices, however, are limited to applications where they will not become plugged with suspended solids or solids which may crystallize from the liquids which they collect. Where applicable, they can be extremely efficient with a pressure drop of only a few inches of water.

### Blowers

Where compressed air service is not available it's necessary to install small blowers to furnish the low pressure necessary for cake discharge from rotary vacuum filters. Small rotary blowers are normally used. Reciprocating air compressors may be adapted. Where reciprocating or rotary vacuum



Fig. 25-A diaphragm pump (Dorr-Oliver, Inc.), air actuated for pumping a liquid slurry.

pumps are installed, the low pressure air may sometimes be obtained, to advantage, from the vacuum pump discharge.

Plant compressed air supply furnishes blow for filters in many cases. Where plant air is at high pressure, it is advantageous to obtain the relatively large quantity of low pressure air needed for rotary vacuum filters by compression of atmospheric air. This can be done in an ejector powered by high pressure plant air. The New Jersey Meter Co. manufactures an ejector designed specifically for this use. Other manufacturers of ejector equipment can furnish such units.

Where plaint air is used, it is often necessary to install additional surge capacity in the air system near the filter, in order to obtain air volumes required for short duration blowback. This surge capacity may be in the form of a tank, or merely an enlarged section of air line.

### Filter Feed Pumps

Pressure filters are usually fed by centrifugal pumps having the desired characteristics to meet pressure requirements. In some cases plunger and diaphragm pumps are used, particularly where constant volume is desired. Vacuum filter feed pumps present no unusual problems, unless crystal or particle breakage is a limitation. Centrifugal pumps for handling slurries should have open impellers and large clearances and should be driven at slow or medium speeds.

Where particle degradation presents a problem it may be necessary to use specialized types such as diaphragm (Fig. 25), plunger or Bump pumps.

### Filtrate Pumps

Removal of filtrate from receivers under vacuum can usually be satisfactorily accomplished by standard designs of centrifugal pumps.

Prime failures can be reduced by connecting a small line from the top point of the pump casing to the receiver, at a point above the normal liquid level. Connection of a similar line to a point near the eye of the impeller is sometimes even more effective. Various designs of self-priming centrifugal pumps are often applied to vacuum filtrate receivers. These units, while somewhat more expensive than standard centrifugal pumps, normally give trouble-free service.

A level controller, installed to maintain constant level in the receiver by actuating a valve in the discharge line from the pump, is a very satisfactory solution. However, when compared to a self-priming pump, the improvement obtained often does not justify the additional cost.

### Filter Feed Tanks

Filter feed tanks represent a holdup of slurry between previous processing equipment and the filter. In some cases they are mandatory. In other cases they are unnecessary. In certain applications they can be justified on the basis of improved filter operation or as a means of maintaining process continuity.

Agitation is normally a requirement and a variety of agitator designs can be satisfactorily employed. The preferred tank design is a cylindrical upright tank having a height to diameter ratio of 1.5 to 3.0. Agitation should accomplish suspension of the slurry without producing violent agitation at any point. Slow-speed large diameter agitation impellers are best for this service. Designs employing a large diameter draft tube are particularly effective where particle degradation is a problem.

### Repulpers

Repulpers are employed to reslurry filter cake with a liquid prior to discharge from the filter. Agitated tanks of a variety of designs are satisfactory. An almost universally satisfactory device is the well known horizontal paddle mixer.

### Filter Media

An essential part of filtration equipment is the filtering surface that blocks passage of solids, and permits the liquid to flow through freely under the existing driving force. The effectiveness of the filtration operation is governed by how well the filter medium performs this job over an economic number of cycles.

On chemical operations the filter medium must demonstrate first its ability to withstand chemical attack, and existing temperature conditions. Next consideration is its effectiveness in delivering a clean filtrate and dry cake at a satisfactory rate.

Then, is it physically suited for the job? It must possess dimensional stability to withstand shrinking and stretching. Solids must discharge freely from its surface and it must remain open or free of blinding. And it should withstand wear from scraping and impact that might open holes shutting down an entire unit.

Fortunately, today there is a wide choice of filter mediums to ease the task of keeping a filter operating at maximum effectiveness. Added to the supply of basic cotton duck, twill and satin fabrics are a host of new synthetic constructions. And stainless steel wire cloth, together with monel, nickel, brass, bronze, aluminum, copper, are available down to 400 mesh.

Cotton is still used widely where there is no danger of attack by acids, alkalis or fungi. The hairy nature of the fiber prevents bleed of solids through the fabric, yet permits free flow of filtrate. And for strength and abrasion resistance it rates high.

### Many Types Available

Since the arrival of nylon as an industrial filtration fabric there has become available a growing supply of many types of synthetics to satisfy almost any conceivable need.

Advantages offered by some of these materials are: nylon—high tenacity both wet and dry, excellent resistance to abrasion and flexing, toughness and elasticity, resistance to heat and many chemicals; Dynel-high chemical resistance particularly to strong alkalis and acids; Orlon-light, strong, resilient, resistant to heat and chemicals particularly acids; polyethylene-resistant to mildew, sunlight and a wide range of chemicals, low water absorption; Dacron-second to nylon in abrasion resistance, low moisture absorption, resistant to mold, mildew, fungus, and chemicals; Teflon-withstands high temperature, is attacked only by fluorine gas, molten alkali metals and tri-chlorine fluorides, no moisture absorption, nothing adheres to it; Saran—exceptional resistance to acids, alkalis, alcohols, aliphatic hydrocarbons.

While due consideration must be given to the chemical and physical characteristics of the fiber, construction of the fabric has a very important bearing on the final performance of the filtration equipment.

In addition to various styles of weaving, synthetic fabric characteristics are altered by using either yarn spun from staple fibers or monofilaments. The amount of twist in the yarn can affect filtration characteristics appreciably. It is said that high twist construction prevents loading of the cloth with solids, permits easier discharge.

Synthetic cloths usually are given some sort of heat-setting treatment to render them dimensionally stable, controlling porosity and surface smoothness.

Still further modification is obtained by, calendering, napping and resin treatment.

### Porous Mediums

Porous metals and plastic filter mediums are getting increasing attention in industrial circles. Various grades of stainless steel, monel, nickel and bronze are available in porous form down to 5 micron mean pore opening Prices on these have been slashed recently to make them competitive with other mediums.

Both Kel-F and Teflon are available in porous form with 5 micron mean pore opening; Kel-F also with 15 micron pores. These mediums have been used for removing solid contaminants from extremely corrosive mineral acids or very highly reactive liquid materials.

# Centrifugals James E. Flood

Centrifugals can separate solids from liquids either by sedimentation or filtration. In either case, they produce greater separating forces than other equipment, broadening the range of solid-liquid separators.

A centrifugal is a mechanical device which applies centrifugal force to mixtures of materials to separate them into components. Centrifugal solidsliquid separators are of two types: filtering machines where the solids are retained by a porous medium while the liquid is forced through; and sedimenting machines where centrifugal force exploits differences in specific gravity to settle out a concentrated solid and overflow a clarified liquid.

Inherently, centrifugals separate materials rapidly so that only a small quantity of material is actually in process at any one time.

On crystalline solids they wash the product efficiently and well; give maximum dryness. They handle fine sludges with consistent performance over extended periods of time.

Centrifugals are compact and neat. In most cases they operate as buttoned-up units to ease plant house-keeping chores.

### Basic Thinking

Theory of centrifugal separations may be classified as: general, sedimentation and filtration.

The force acting on a particle within a centrifugal field is defined by Newton's fundamental force equation, F = ma. Acceleration acting on the particle, directed toward the center of rotation, is  $a = r \omega^2$ . Therefore, the centrifugal force acting on the particle is  $F = mr \omega^2$  or expressed as multiples of gravity  $F = 14.2 \times 10^{-6} \text{ DN}^2$ .

Tensile stress in a rotating bowl,

empty or loaded, is directly proportional to the square of the surface speed, not the rpm. Therefore, for a given bowl stress greater centrifugal force can be attained by a small bowl rather than a large one. Thus, small diameter bowls are always used for generating high centrifugal forces to avoid stressing the bowl beyond safe operating limits.

The adjoining table compares speed and centrifugal force for different diameter bowls operated to give equal stresses in the bowl walls.

Application of the centrifugal force equation to design of centrifugal equipment is covered in Perry's handbook. Mathematical analysis of the operation of liquid-solids separators is also covered in this source.

By reviewing Perry's the reader can gain a clearer understanding of operation and valuable assistance in making machine adjustments to separate most efficiently. But application of this theory to a new sedimentation job must be backed up by preliminary small-scale tests.

The Sigma concept, introduced recently by C. M. Ambler, Chem. Eng. Prog., Mar. 1952, p. 150-158, makes possible comparative evaluation of sedimentation-type centrifugals. It puts all these centrifugals on a mathematical basis which reduces the centrifugal to an equivalent settling basin.

By using the Sigma concept, various sedimentation centrifugals can be compared on an equal footing. Once actual performance data is obtained for one centrifugal the performance of all other sedimentation machines can be predicted. However, it is required that actual operating data be available for one machine. It is not possible to predict performance without this initial starting point.

Theory of centrifugal filtration has been studied extensively. An out-

standing contribution, (H. P. Grace, Chem. Eng. Prog., Aug. 1953, Resistance and Compressibility of Filter Cakes, Part III: Under Conditions of Centrifugal Filtration) is the development of compression permeability techniques. By this method specific cake resistance can be determined under varying pressure conditions. It can be used for sizing centrifugal filters approximately when centrifugal force is substituted for the hydraulic pressure drop or the  $\Delta$  p of pressure filtration.

### Centrifugal Selection

In many cases, it is comparatively simple to narrow to a few basic types the selection of a centrifugal for a given application. However, final selection of the best unit for the application is quite complicated. Further complications arise when alternate methods of mechanical separation such as filters, settling tanks, liquid cyclones, etc., must be considered along with centrifugal equipment.

It is quite important to consider the entire separation process when selecting mechanical separating equipment. The centrifugal may dry crystals sufficiently so that subsequent drying is not required. Also, centrifugal dewattering may leave only a small amount of original mother liquor on the cake, so that only a small amount of wash liquor is needed to remove the remaining traces.

A few words of caution are necessary to you who must evaluate a

### Nomenclature

- m Mass of a particle, gm.
- a Acceleration, cm/sec<sup>a</sup>
- r Radial distance of a particle in a centrifugal field from the axis of rotation.
- ω Angular velocity, radians per sec.
   D Inner diameter of centrifugal bowl, in.
- N Bowl speed, rpm.

### Holding Stress Constant, Force Climbs as Diameter Decreases

Bowl diameter, in	12	24
Surface speed, ft./sec	167	167
Rotational speed, rpm		1,600
Centrifugal force, gravities	1,740	870
Stress in bowl	Same f	or both

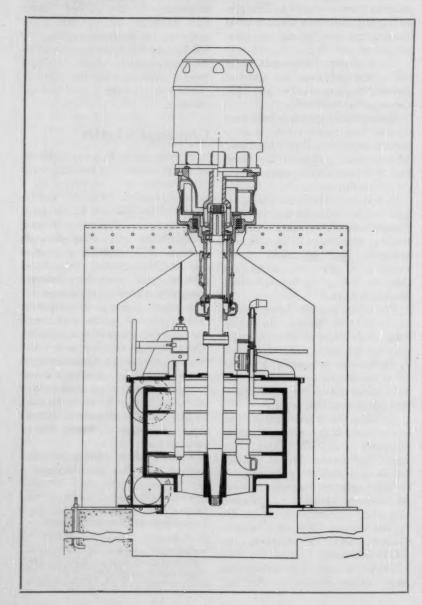
separation problem and select centrifugal equipment.

- Material that is tested on small scale units must be identical in every way with that which will result from plant operation. Reliability of predictions will fall off with divergence in properties of the two compared materials.
- In general, the science of centrifuging is not developed well enough to predict performance of one type from tests on another type centrifugal. Past

experience is a valuable guide in predicting the performance of one type of centrifugal from the results obtained with another centrifugal. But in almost every case, you need confirmatory tests before firm recommendations can be made. Even appreciable extrapolation to a larger machine of the same type may be unreliable.

 Choose a centrifugal only after adequate test runs have confirmed the application. Where possible, make actual full-scale runs.

Fig. 1—Batch suspended imperforate-basket centrifugal removes fine solids from liquid. Feedpipe discharges into bottom of basket; clear liquor overflows top; solids are plowed out through bottom. (Bird Machine Co.)



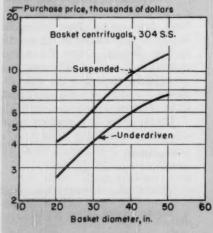
• Exercise caution in deciding against a given centrifugal if the decision is based on preliminary laboratory tests, because further work may indicate differently.

• Centrifuging, like filtration, often can be improved greatly by taking steps to insure that solid particles are not degraded or broken up prior to centrifuging. Much evidence indicates that crystalline materials and aggregates often may be degraded by pumps and mixers. It follows that you should choose pumps and agitators carefully to get gentlest action for the shortest time consistent with process requirements. It may pay dividends in greatly increased centrifugal throughput.

For the same reason, one centrifugal may be preferred to another because it is designed to handle materials with less defloculation or less crystal breakage. If permissible, floculating chemicals may be used to promote free drainage and good centrifugal filtration.

• If you are confronted with a given mixture which previously has been centrifuged successfully, you may tentatively select an applicable centrifugal from those which have handled the same type of material before. As a corollary, full-scale tests always will be run to select and size a centrifuge for each new material.

Development of centrifugal types and sizes for the chemical industry has been influenced by the mechanical properties of available construction



### Fletcher Works, Inc.

Suspended and underdriven batch centrifugals, perforate and imperforate baskets.

				- Under	driven -						- Susper	ideds -		
		Standard			nior		Whirlwin	d						
Bowl, diam., in		17	20	26	30	40	48 21	60 21	20 10	24 14	30 15	-32 19	40 24	48
height, in Normal speed, rpm	2,100	1,500	11 1,400	12 1,200	1,100	20 900	750	600	1,750	1,150	1,150	1,150	1,150	850
Centrifugal force (×G).  Normal hp	682	540	550	530	490	459 7½	382 10	300 121/2	800	450	550	580	730	500
Solids holding capacity		0.5	0.9	1.7	2.8	8.3	12.5	18.0	1	2	3.2	5.5	9	12.5
Approx. prices	\$1,100	0.5 \$1,700	\$2,000	\$2,800	\$3,000	\$6,500	\$8,000	\$10,000	\$3,300	\$4,100	\$5,200	\$5,900	\$7,000	\$9,300
Solids discharge mechan- ism	Manual							*******	Manua	or plow	, including	g automa	tie	

Can be furnished in steel, stainless steel, Monel, copper or bronse, rubber-covered steel, etc. (a) Bottom discharge = ½ times basket diameter with disk or cone valve. Open bottom "Lewis bottom" gravity discharge baskets available. (b) A laboratory model of this size is available with interchangeable solid and perforate baskets and bottle or test tube holder. (c) Prices for underdriven machines are for 304 stainless fume-tight contruction and explosion-proof motor and control. Prices for suspended machines are based on carbon steel construction, fume hood, mechanical unloader with speed control and 2-speed explosion-proof motor and control.

materials such as tensile strength, impact resistance, etc. Problems of corrosion, gasketing and lubrication also influence design and selection of centrifugals.

Over the last quarter century, many basic types of centrifugals have been introduced to the chemical and processing industries. Some of these units were devised and developed for specific applications and, after initial success, were tried in other fields.

Acknowledged advantages of centrifugal separation have impelled both process engineers and centrifugal designers to adapt known methods of utilizing centrifugal force to the needs of mechanical separations encountered in industry.

### Batch Centrifugal

The batch centrifugal is the most widely applied centrifugal in the chemical and processing industries. It has been used on practically every type of solids separation from free-draining crystal-dewatering services to removal of small quantities of slimy solids from liquids. There are two basic types of batch centrifugals: suspended top-driven units and underdriven units.

Suspended basket units have the basket mounted on a long spindle supported on an overhead bearing assembly, Fig. 1. The basket usually is driven through a flexible coupling mounted at the top of the spindle.

Underdriven units with the basket mounted on top of a short spindle are driven through the base of the spin-

Various types of bowls are available for either of these units: perforate basket for centrifugal filtration; imperforate or solid basket for centrifugal sedimentations; and special baskets for impregnation, galvanizing, enamelling, and numerous other special applications. The perforate-basket centrifugal acts as a filter and is used for filterable materials. It is ideally suited for coarse crystals that must be thoroughly washed and dewatered.

Liquid spins out of the centrifuged cake due to its own weight multiplied by the centrifugal force factor of the machine. Therefore, free draining crystals dewater to a greater degree on a centrifugal than on any other type of mechanical separation equipment.

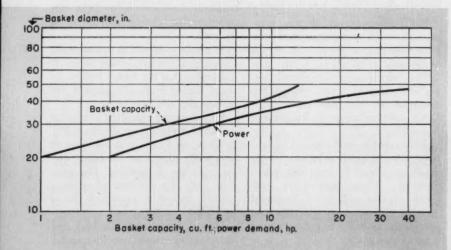
The imperforate-basket is used as a clarifier or a classifier. Feed, distributed evenly at the bottom of the basket, moves upward through a series of baffles which prevent channeling, short circuiting and surging. Effluent flows over the lip of the basket. Solids settle out of the feed and collect against the basket wall.

Operating as a clarifier essentially all the solids settle out of the liquid and the effluent is clear. On classifier service, only the oversized and/or heavier particles are removed from the liquid while the fine solids are discharged with the effluent.

Special baskets are too numerous to cover in detail, but a brief listing shows the versatility of batch units.

- Washer—cleans cutting oil and compounds from small machined parts.
- Impregnator—saturates a porous body with a liquid. Hydrostatic pressure forces the impregnating liquid to permeate the porous body. Yarns, braids, ceramics, etc., can be impregnated in a few minutes time.
- Enameler—spins excess enamel off small parts to give a thin uniform enamel coat.

Operation — On perforate-basket machines slurry is fed while the machine is at rest or turning slowly. Then



the basket is accelerated to full speed to spin out the liquor, dewatering the solids.

Wash liquor may be sprayed onto the cake while the basket is at top speed, or some intermediate speed. A relatively long spin at top speed effects final drying. For unloading, the machine is stopped or rotated slowly and the finished solids rimmed by a plow.

Suspended-basket centrifugals discharge cake from the bottom of the basket to a container or conveyor below the machine. On underdriven units, cake is removed manually from the top of the basket.

Advantages—The batch centrifugal is the least expensive of all centrifugal equipment and has rather wide spread application. The general design lends itself to many materials of construction such as steel, stainless steel, rubber covered steel, Monel, bronze, etc. Vapor-tight enclosures are available for toxic materials or volatile solvents.

Baskets can be designed specially for a given application. Batch operation permits running cycles that give optimum efficiency.

In the sugar industry, batch units have established a standard of separating and washing performance that continuous centrifugals have not been able to meet.

Limitations—These centrifugals are batch units requiring operator attention. Normally, they are not as economic as continuous centrifugals, automatic batch centrifugals, or filtration equipment on high-tonnage production applications.

Conversely, they are used more generally on low to medium tonnage production services where they are more economical than the continuous or automatic batch equipment.

Control—Since the batch centrifugal is operated manually, various process controls are under the operator's supervision. Push-button controls usually are provided for start, stop, feed speed, top speed, and unloading speed. Feed and wash liquors usually are controlled by means of manually operated valves.

Slow-speed feeding may be necessary to provide a balanced load before the basket is spun at full speed to dewater the solids.

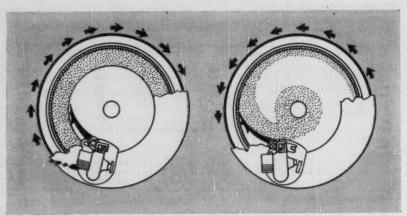


Fig. 2—Unique unloader for continuous suspended batch centrifugal. Plow trails the direction of spinning rotation; it can't accidentally dig into solids. To unload, basket is stopped and rotated in opposite direction. (Western States)

Maintenance—As with most rotating equipment, maintenance problems center around proper installation to minimize vibrational effects, proper and frequent lubrications, bearing replacement, brake adjustment and brake lining replacement. With a properly engineered installation and manual operation, maintenance on a batch centrifugal is not a large item. In fact, filter cloth or screen replacement may be one of the principal items of expense.

Periodic inspection and preventivemaintenance schedules ensure a minimum of unscheduled down time. Drive assembly inspections and bearing replacements frequently are made on schedule, to insure a smooth running unit with less chance of an emergency shut-down.

### Batch Automatic Centrifugal

Batch automatic centrifugals are essentially batch centrifugals that have been modified to provide continuous or automatic operation. Cycle controllers, which are usually electric timers and solenoid valves, control the operation of the feed valve, wash liquor valve, motor speed changes, and unloading.

Unlike batch centrifugals, different basic types of batch automatic centrifugals are offered by only four manufacturers. These units differ sufficiently so that each will be discussed in turn. One is a suspended type; the others are mounted to rotate around a horizontal axis.

### Western States

The continuous batch machine offered by Western States Machine Co. is essentially a conventional suspendedbasket batch centrifugal modified to load, dry, plow and restart the next cycle automatically.

Developed for the sugar industry these units represent, to date, the most successful approach to continuous centrifugation for sugar applications.

To accomplish full automation of the batch unit, Western States developed many novel answers to old problems that have obstructed automatic operation of a batch centrifugal.

Loading is controlled through a pneumatically operated gate. The load in the basket is measured by a feeler which contacts the sugar wall and moves out as the sugar builds up in the basket. A servo-motor mechanism translates movement of the feeler to a corresponding closing movement of the gate.

The bottom closure is an automatic air-operated, conical, basket valve. It it essential that the basket bottom be closed during loading to prevent any spillage into the sugar conveyor.

For automatic unloading the basket is rotated in the reverse direction, Fig. 2. Thus, no longer is it necessary to remove the plow from the basket during high speed spinning. The plow shoe trails the direction of spinning rotation and it is impossible for it to dig into the sugar wall.

Plow is moved vertically by a double-acting air cylinder; another air cyl-

### Important Types of Centrifugals

Centrifugals	Normal Operation	Manufacturers*
Suspended basket Perforate Solid	Batch	D, E, F, G, H, K D, E, F, H
Underdriven basket PerforateSolid		D, E, F, H B, D, E, F, H
Batch automatic Super D Hydrator	. Continuous	A
Clarifier	. Continuous	1
Continuous Conveyor discharge Solid bowl, cylindrical. Solid bowl, conical. Screen, cylindrical. Pusher discharge ter Meer.	. Continuous	D, L
Tubular Super Centrifuge ClarifierSeparator	. {Batch, requires}	Â
Disk Standard Clarifier Separator	. (Batch, requires)	A, B A, B
Sludge discharge Clarifier Separator	. Continuous	A, B, C, M
Underflow recycle Clarifier Separator	Continuous	C

### \* Representative Manufacturers of Solid-Liquid Centrifugals

Cod	e Company	Address
A	The Sharples Corp	23rd & Westmoreland St., Philadelphia, Pa.
В	The De Laval Separator Co	Poughkeepsie, N. Y.
	Merco Centrifugal Co	
D	Bird Machine Co	South Walpole, Mass.
E	Fletcher Works, Inc	Glenwood Ave. & 2nd St., Philadelphia 40, Pa.
F	Tolhurst Centrifugals Div	East Moline, Ill.
	American Machine & Metals, Inc.	
G	The Western States Machine Co	Hamilton, Ohio
H	American Tool & Machine Co	
I	Heyl & Patterson, Inc	55 Water St., Pittsburgh 22, Pa.
J	Baker Perkins, Inc	Saginaw, Mich.
K	Geo. L. Squier Mfg. Co	465 Broadway, Buffalo 4, N. Y.
	(Buffalo Forge Co.)	
L	Centrifuge Mechanical Equipment, Inc.	Seaboard Trust Bldg., Hoboken, N. J.
M	Pitmar Corp., (Titan)	10 East Fayette St., Baltimore, Md.

inder moves it horizontally inward while a spring returns it when air pressure is released. Then the bottom closure reseats automatically.

Western States is offering a 48-in. dia. basket centrifugal set-up with the automatic cycle. Although the unit has been applied successfully only on sugar, the manufacturer is confident it will find many applications on mechanical separation problems of the chemical industry.

### Sharples

The Super D Hydrator built by Sharples Corp. is a horizontal-axis perforated-basket centrifugal which operates at a constant speed throughout the entire cycle of feed, rinse, spin, and unload. Two sizes, 20- and 27-in. dia. baskets, are available with perforate basket design only.

On a normal cycle, feed is admitted through a valve. The crystal-distribu-



Fig. 3a—Batch automatic centrifugals separate salt crystals from caustic liquor at large Eastern installation. (Sharples)

tor knife "levels" the cake and maintains a balanced basket load.

Feed is stopped when the cake reaches a preset thickness or when the feed-timer period is completed.

Rinse is admitted through a rinse valve which remains open for the timer-controlled rinse period. Following rinse, the cake is spun dry during the timer-controlled spin period.

Cake is unloaded by a hydraulically operated knife assembly that raises into the cake and slices out the crystals which are deflected to the discharge chute.

The unloading knife leaves a thin layer of crystals on the screen. Usually, this residual cake is "softened" or dissolved by a short rinse after each batch or after a preset number of batches.

During the cycle a number of rinses can be provided. An automatic diversion valve can be installed in the effluent line to separate the wash liquors from the strong liquors.

Main design features of this unit are constant basket speed, fast unloading and rapid cycles.

Speeds of 1,800 rpm. for the 20-in. dia. unit and 1,550 rpm. for the 27-in. unit eliminate the acceleration and deceleration periods of other units and the entire basket load is removed by a single upward motion of the unloader knife assembly.

Approximately 1 cu. ft. for the 20-in. and 2 cu. ft. for the 27 in. dia. unit are processed on a cycle of 30 to 60 sec. Thus, a small unit can handle

as much as 3-5 tons/hr. of free filtering crystals.

### **Baker Perkins**

In general design and operation, the Baker Perkins is similar to the Sharples Super D Hydrator and Reineveld unit.

Two types of operation are possible:
(a) Centrifugal filtration with a perforate basket unit or (b) centrifugal sedimentation with an imperforate basket.

### Reineveld

The Reineveld centrifugal is manufactured in Holland, but sales in this country are handled by Heyl and Patterson, Inc. A view of this machine is shown in Fig. 3.

The machine has been opened by unbolting and rolling out the cover plate along the I-beam trolleys which are an integral part of the centrifugal. The cover plate of the larger machine, i.e., 67 in. and greater, is installed in a manner reminiscent of a bank safe and opens like a door. In Fig. 3 may be seen the cake cutting knife, the discharge chute and the feed tank nozzle.

The operating cycle is adjustable and under full automatic control. It includes charge, dewater, wash (one or more) cut out and screen rinse.

Reineveld centrifugals are made in various sizes with both perforate and imperforate bowls.

Size, In.	Bowl Volume, Ft.3	Force (G's
16	0.39	2.016
28	1.37	1.580
36	4.27	1,134
36S	3.5	1,650
50	13.6	980
67	29.6	737
79	36.9	870

Several special features are claimed by the manufacturer for the Reineveld centrifugals.

Rapid feeding is used. This is claimed to form a classified cake bed before the liquid drains out. Heavy particles are near the bowl wall, and the lighter ones are on top of the cake. This classified structure is said to drain quicker.

With rapid feeding, there is turbulence in the bowl during feeding. Final cake surface will be just concentric with the axis of rotation making use of a leveler unnecessary. This should decrease crystal breakage. The main bearing is located at the center of gravity, for quieter running and less bearing wear.

### **Essential Points**

Advantages—Automatic batch centrifugals are ideally suited for large tonnage production of free filtering crystalline slurries. They offer low cake moisture, good washing efficiency and relatively clear filtrate. Operating labor is minimized since one operator can easily handle many centrifugals.

Limitations—Maintenance costs on these units may be sizeable because they are precision-made equipment which require skilled maintenance.

While the automatic cycle equipment is constructed quite ruggedly the parts in electrical timers, electrical solenoid valves, and air operated diaphragm valves are sufficiently numerous to increase maintenance.

The unloader knife may be a source of high maintenance on abrasive service. However, recent introduction of abrasion-resistant unloader knives has greatly reduced replacement costs.

Major items that must be watched are: unloader-knife service life, leveler service life, automatic cycle equipment, and the feed and rinse valves.

Control—Almost an infinite variety of cycles is possible with these units; multiple rinses, screen rinses every batch or after a preset number of batches, divergence of effluents, etc.

In addition, slurry level in the feed tank can be used to lengthen or shorten the spin cycle automatically as the inventory of slurry changes ahead of the centrifugal.

Installation—Proper installation is important to eliminate vibration which may lead directly to maintenance problems. Normally, these units are set on a massive concrete foundation that is heavy enough to absorb the usual out-of-balance loading that may be encountered during operation of these units.

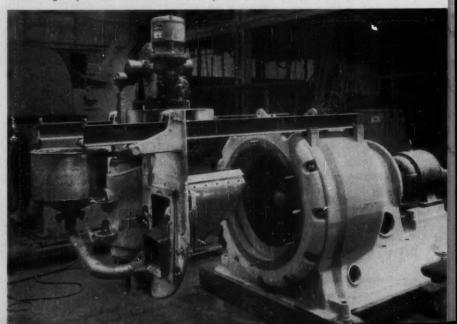
### Tubular Centrifugals

As previously indicated tabularly, high centrifugal forces can be obtained when a small-diameter bowl spins at high speeds, without unsafe stresses in the bowl wall. Such a tubular bowl machine, the Sharples Super Centrifuge, develops a relative centrifugal force up to 16,000 G's with a 4-in. dia. bowl. These units are used for clarification and liquid-liquid separations where the amount of solid phase is low—say below 1%. Solids are removed manually during shut-

### Continuous Centrifugals

Truly continuous centrifugals fall into two categories: screw-conveyor type with various bowl designs, and pusher (ter Meer) type.

Fig. 3b-Reineveld 36-in. automatic batch centrifugal showing roll-out front cover and knife cut-out mechanism. Rapid feeding promotes free drainage. Main bearing at center of gravity reduces wear and noise. (Heyl & Patterson, Inc.)



### Solid Bowl

As shown in Fig. 4 this equipment has a horizontally-mounted solid bowl with an internal conveyor-scroil. Both bowl and conveyor revolve in the same direction.

The centrifugal is driven by V-belt pulleys on the trunnion at the feed end of the machine on the right. Rotation of the bowl is transmitted through a planetary gear system, in the round box on the left, to the conveyor, driving it at a speed 10-40 rpm. slower than the bowl. This differential speed between conveyor and bowl serves to eject solids continuously from the bowl.

The fixed point of the gear train is extended by means of a pinion and

shear pin to an external torque arm held motionless by a bracket. If load on the conveyor screw becomes excessive the shear pin breaks permitting the loaded screw conveyor to rotate at the same speed as the bowl. Solids ejection ceases.

Feed slurry enters into the chamber inside the conveyor assembly through an axially located pipe. Ports around the periphery of this chamber distribute the material into the bowl.

Centrifugal force holds the material against the bowl wall. The heavier solids form a layer directly against the bowl with the liquid on top. The conveyor moves the solids along the bowl wall up the inclined "beach" and out the solids-discharge ports at the small end. Clarified liquid flows out through

discharge ports in the large-end bowl head on the right.

Pool depth is set by regulating the position of the ports in the bowl head. On one design, Fig. 5, an eccentric hole is drilled in the circular plate that is mounted over each filtrate port. By rotating the plate, the position of the eccentric drain hole is changed with respect to the axis of rotation. All plates are rotated the same degree to change liquid pool level inside the machine.

The machine case surrounding the bowl is compartmented and connected to hoppers that direct effluent and cake into piping and conveying systems.

Where washing is required, the wash liquor is fed through a pipe, concentric with the feed pipe, that extends into the wash liquor chamber inside the conveyor assembly. Wash nozzles on the conveyor hub spray the liquor against the pile of solids moving in front of the helical blades along the beach.

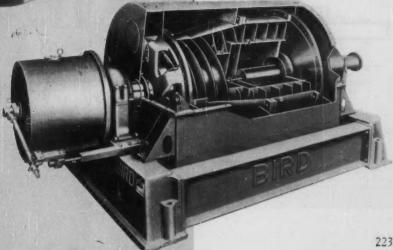
While the degree of washing may not be equal to that obtained with batch equipment where wash cycle time can be controlled, relatively good removal of impurities is possible.

Several different bowl configurations are built for solid bowl machines. The older conical bowl generally is used with relatively fast-settling, free-draining solids. It can be operated with the edge of the pool extending only a short distance up the incline. The long drainage section extending from this point to the solids-discharge ports favors maximum cake dryness.

On the other hand the small pool



Fig. 4—Heavy tonnage, solid bowl, continuous centrifugal incorporates combination bowl to give both good clarity and dryness. (Bird Machine Co.)



volume allows only minimum retention of the liquid under centrifugal force. Net result may be some carryover of solids with the effluent, particularly on finer materials.

Finer sludge-like materials can be handled to better advantage with cylindrical bowls. With this type of bowl the conveyor O.D. is tapered only at the cake discharge end of the unit. Solids pack into the space between the conveyor taper and the bowl wall to form a beach for removal of the cake from the pool.

In general, the increased pool volume obtained with the cylindrical bowl produces better effluent clarity. Also, many separations handled by this equipment cannot be handled satisfactorily with the conical bowl.

Cake discharge from a cylindrical machine may have higher moisture content. However, this is generally due to the nature of the solids where fineness makes moisture content a function of degree of compaction and surface area rather than drainage.

Recent designs have incorporated features of conical and cylindrical design in a combination bowl, Fig. 4. The effluent end of the unit is cylin-

drical for good clarifying efficiency while the solids end is conical to increase cake dryness and improve conveying.

One screw-conveyor centrifugal is built with a perforated or screen-type bowl. It is similar to the solid bowl units described above in that the unit has a screw-type conveyor and differential speed ratio between conveyor and bowl.

The bowl is perforated and has a slotted screen to retain the solids. Feed enters through a central pipe and deposits on the screen at one end of the bowl. Liquor drains through the cake and screen to the filtrate housing. Cake is conveyed along the screen through the washing and final dewatering zones to the discharge section.

### Ter Meer (Baker Perkins)

The Ter Meer type continuous centrifugal is illustrated in Fig. 6.

Feed enters through a pipe and is accelerated to full peripheral basket speed in traveling along the cone which rotates with the basket. Liquid is flung out through the basket holes by centrifugal force leaving the solids retained in the basket.

The pusher reciprocates forcing the solids to travel along the basket where further centrifugal dewatering, washing, and final dewatering takes place. The solids are then forced over the edge of the basket and into the dry solids housing.

Mother liquor and wash filtrates can be separated by properly baffling the housing or covers. The pusher is reciprocated by a hydraulic system that applies pressure on each side of the double-acting cylinder and piston. Amplitude and frequency of the "oscillations" can be adjusted for optimum separation desired on each application.

The Ter Meer pusher-type centrifugals are suitable for relatively free draining crystalline, granular and fibrous materials. No rakes or plows are needed to maintain balanced loads because the combination of pusher and feed cone provides a well distributed, evenly balanced cake.

Because of mechanical design problems associated with the pusher arrangement and drive, the Ter Meer is operated at somewhat slower speeds than other continuous centrifugals. But with the free draining materials

Fig. 6—Ter Meer perforate-basket continuous centrifugal has reciprocating pusher to discharge solids continuously from machine. Filtrate and wash are separated. (Baker Perkins)

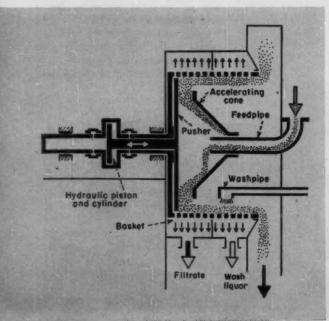
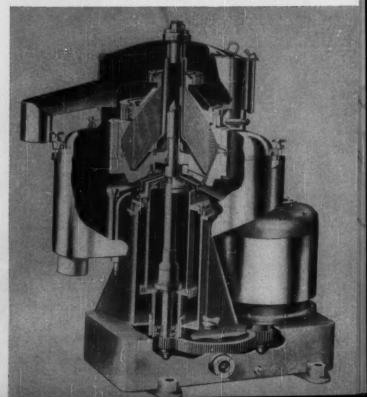


Fig. 7—Heavy-duty DH-3 Nozljector concentrates and/or separates up to 300 gpm. Available with either standard nozzle disk bowl or re-cycle bowl shown. (Sharples Corp.)



### Bird Machine Co.

Continuous conical, cylindrical and contoured cylindrical solid bowls. Continuous screen. Batch suspended perforate and imperforate baskets.

-			us solid bowl	machines -	1 - 1-	Continuous cylindrical screen	Suar		sket mach imperfor	
Bowl, diam., in	180	24*	32(36)	40(36)	54.	24	12	26	40	48
height, in	28	38	50	60(72)	70	24 .	436	16	24	24
Max. speed, rpm	3,000	2,400	1,600(1,200)	1,400(1,200)	900	1,200	3,600	1,8000	1,800/	1,200
Centrifugal force max. (XG)	2,250	1,930	1,180(740)	1,180(740)	600	490	2,160	1,165	1,800	960
Normal hp	15	25	60	75	150	25	*****	15/3.74	30/7.54	40/104
throughput)	0.6 cfm.	1.2 cfm.	3.0 cfm.	10(3) cfm.	40 cfm.	1 cfm.	0.17 cu. ft.	2.5 cu. ft.	8.9 cu. ft.	12.5 cu. ft.
Normal throughput, gpm	30	70	150	250	600	*******	*****	******		*****
Weight of machine, lb.4	2 800	5,400	12,000	17,000	32,000	*******	800	3,200	9,500	10,500
Approx. price	<b>\$7,300-</b>	\$11,000-	\$16,000-	\$20,000-	\$35,000-	\$14,000-	\$1,700-	\$3,500-	\$4,800-	\$5,200-
	9;600	16,000	25,000	31,000	50,000	21,000	2,000*	5,500m	9,900*	10,000»
Solids discharge mechanism	Continuou	s discharge by	y conveyor			Continuous discharge conveyor	Plow			

<sup>(</sup>a) Max. diameter for conical bowls. Diameter for cylindrical bowls. (b) Two machines available with max. diam. and length indicated. (c) Prices are for steel and 316 stainless steel. Prices do not include drive except as indicated. Add monoral hoist for handling and \$2,000 for automatic feed control. Concrete foundation, if needed, will be 4 times machine weight (continuous machines). (d) Does not include weight of motor. (e) Price includes motor drive. (f) Can furnish 1,800 rpm. machine at extra cost of \$1,800. (g) Can belt-drive at 2,250 rpm. with same motor at \$500 extra cost. (h) Two speed motor. (m) Add \$7,00 for explosion-proof motor.

### Sharples Corp.

Tubular, disk, batch automatic, continuous conical and cylindrical solid bowls.

	Super-Ce	ntrifuge		— Disk	Гуре —			Super-D-Canter		Super-D-Hydrator	
	Lab. Size	#16°	DD2	DH3	DG2	DV2	Conical Bowl	Cylindrical Bowl		C-20	C-27
Bowl, diam., in	1.75	4	11.25	12.5	11.25*	11.25	14 × 8	14	4	20	
height, in	8	30					23	23	7	10	
Normal speed, rpm	50,0004	15,000	6,000-	4,000-	6,000	6,000	1,500-	1,500-	To	1,200 to	800 to
			7,600	6,250			4.000	4,000	6,000	2.100	1,800
Centrifugal force max.									-		1,110
(×G)	62,400	13,200	10,400	10,500	9,500	9 500	3,190	3.190	2,100	1.250	1,240
Normal hp	0.5	2	6	15 to 50	20	20 to 40	10 to 15	10 to 15	34	20	30 to 50
Solids holding capacity.	200 c.c.	1 gal.	1.9 gal.			8				1 cu. ft.	214 cu. ft.
Approx. price	\$950-	\$2,500-	\$4.500-	\$10.500 to	\$16,000	\$19,850	\$10,000 to#	\$10,000 to*	\$3,350	\$15,000A	\$20,0004
	\$1,500	\$7,000°	\$8,500/	\$18,500			\$15,000	\$15,000		to \$21,000	to \$27,000
Solids discharge mechan-											
ism	Manual	Manual	Manual	Continuous	Automa	tic valves	Cont	inuous discharg	0	Knife autom	atically cuts

<sup>(</sup>a) Disk diameter. (b) Self-cleaning bowls. (c) Variety of sizes and shapes made for special applications. Materials include dip-coated tinned steel, 804 stainless steel, Monel, Inconel. (d) Speeds for turbine drive. (e) Top price is for complete stainless steel, totally enclosed for pressure operation. (f) Range: tinned steel to vapor-tight stainless steel construction. (g) Range: open stainless steel to vapor-tight Monel with wearing parts surfaced with tungsten carbide. (h) Monel or stainless steel depends on enclosure and extras such as valve and timers. Normal cycle has four parts. Does not include motor.

### Baker Perkins, Inc.

Ter Meer continuous pusher discharge, Universal perforate and imperforate baskets.

			Co	ntinuou						1	niversal	Perfor	ate)		
Sizes	S-125B	S-12LE	S-13.5		S-21	S-32	S-48	HS-45	HS-18		W HS-24W			HS-66	HS-81
Bowl diam., in Centrifugal force (×G) Normal hp Total bowl volume.		12 1,000° 7 1/2	13.5 450° 10	15 450° 20	21 400* 30	32 300* 50	48 250* 75/30*	18 1,000° 3	18 1,000° 5	20 1,000° 20	24 1,000° 15	36 900* 30	54 600* 50	65.625 450° 75/1.5³	81 350° 125/1.5°
cu. ft	*****				*****	*****	*****	0.29	0.500	1.08	1.75	4.15	12.3	20.5	36.1
Nominal capacity, lb.	Hydraul	ic pusher						Knife o	uts out c	ake					
per hr	640° \$10,000/	2,500° \$12,300	5,000° \$14,000	8,000° \$16,000	16,000° \$28,000		50.000° \$50,000	\$6,500/	600d \$10,000	2,000 <sup>4</sup> \$13,000	3,0004 \$16,000 \$	4,500d 26,000	7,000 <sup>-4</sup> \$38,000		16,2004 Special

<sup>(</sup>a) Speeds depend on type of material used in construction. Figures based on stainless steel (A.I.S.I. 304 or 316). (b) Second figure is pump motor size: Single figure is single motor drives. (c) Capacities given are for granulated salt discharged @ 2% moisture from feed slurry @ 120° F. 50% solids by weight and having a particle size such that 80% is plus 80 mesh and 90% on 100 mesh screen. 60 pounds per cubic feet solids. (d) Capacities given are for cake discharge @ 13.5% moisture from a slurry of 20% solids by weight having a particle size of 60% on 200 mesh and 80% on 400 mesh screen. Capacities will vary according to material handled and temperatures involved. Cake discharge can be as low as 1% moisture depending on product. (e) Hand operated for general laboratory use. (f) S-12-SB and H-450 includes motor. Prices quoted stainless steel (A.I.S.I. 304).





Fig. 8—Battery of ACVO nozzle-discharge disk-bowl centrifugals producing pure fish oil from a slurry of oil, water and fine solids discharged from cooker. (DeLaval Separator Co.)

Fig. 9-Model C-30 continuous nozzle-discharge centrifugal at Corn Products' Corpus Christi plant. Used either as a classifier or clarifier, unit handles more than 300 gpm. (Merco Centrifugal Co.)

handled by this centrifugal, the lower centrifugal force is not a disadvantage.

Filtrate from the ter Meer usually contains fine solids that pass through the screen. Agitation of the crystals, as they are shoved down the basket, tends to separate the fines from the crystal bed, allowing them to pass through the basket to the filtrate housing.

### Disk Centrifugals

Machines in this category operate at high centrifugal force. While they all stem from a basic cream-separator design for liquid-liquid separations they can remove various quantities of solids from one or two liquids, concentrate the solids in the heavier liquid or classify solids.

Basically, all machines of this type have a bowl that rotates around a vertical axis. Inside the bowl is a stack of conical disks with spaces between the individual disks. Several vertical holes through the stack distribute feed and are located so that they are the locus of the interface.

Feed enters the unit from the top, passes down through the center to the bottom of the disk stack, then up through the feed holes into the stack. Heavy liquid and solids move toward the outer periphery of the stack while the light phase stays in the central section of the stack. Heavy and light liquids discharge as separate streams at the top.

The disks actually provide the equivalent of a large settling area within a confined space subject to centrifugal force. Each space between disks is a settling zone where settling

distance to the inclined under surface of a disk is only a small fraction of an

### **Design Variations**

The original cream separator type operates batchwise. Dirt or solids removed from the feed collect in the dirt space between the O.D. of the disk stack and the I.D. of the bowl. When this space is filled, the operation must be stopped and the bowl disassembled and cleaned.

Many novel schemes have been developed to provide truly continuous operation of these units by removing the solids continuously, eliminating need for bowl cleaning.

Each of the various schemes offers some advantage along with inherent disadvantages. Thus, selection of the right centrifugal for an application must be based on actual performance data obtained from full scale tests on representative material.

The simplest approach to automatic sludge discharge is to provide holes in the peripheral surface of the bowl. One such nozzle-discharge centrifugal separates two different liquids and discharges heavy liquor and solids through the nozzles.

To efficiently remove the sludge, numerous nozzles are needed. The angle of repose of most solids is approx. 45° and on a 16-in. dia. unit from 6 to 12 nozzles are required to remove sludge adequately.

The cross-sectional area of each nozzle must be reasonably small because

### Merco Centrifugal Co.

Disk machines, notably those with underflow return.

	Model 9/	Model 16	Model 30	Model 24
Bowl diameter, O.D., in	11	21	40	26
Bowl height, in	10	201/4	26%	211/4
Normal speed, rpm	3,000-9,000	3,000-6,000	2,200-3,000	400-1,900
Max. centrifugal forces (XG).	7,000	5,000	2,500	1,000
Liquid throughput <sup>5</sup> , gpm	1-20	10-100	50-300	10-300
Normal mtls. of construction				
Bowl c	316 8.8.	316 8.8.	316 S.S.	316 S.S.
	410 8.8.	Carbon steel		Carbon steel
	Carbon steel			
	Hastelloy-C			
Housing	316 8.8.	316 S.S.	316 S.S.	316 S.S.
	Bronze	Bronze	Bronse	Cast iron
	Carbon steel	Carbon steel		
	Hastelloy-C			
Approximate price 316				
stn. steel rotor and housing.	\$7,125	\$15,925	\$37,540	Carbon steel rotor,
				Cast iron housing-
				\$7,875
Drive', hp	15	30-60	100	20-40

<sup>(</sup>a) The values of maximum centrifugal force are calculated at the center of gravity of the cross-sectional area of the separating chamber, i.e., the area between the nossles and the inside diameter of the disk stack.

(b) Liquid throughput depends on the characteristics of the feed alurry and the separation required.

(c) The solids are discharged continuously as a slurry from the nossles at the periphery of the rotor.

(d) These approximate prices do not include drive. (e) The power required depends on feed rate, nossle size, and speed of operation. (f) This model centrifuge is often used in pilot plant evaluation work, and is usually available on a rental basis within two to three weeks.

discharge pressure is in the range of 500-600 psig. Despite small nozzle orifices, flow rate may be much greater than feed rate to the unit.

Power is consumed to pump liquid through the nozzles; only a small portion of the energy can be recovered by jet action. Make-up of the heavy liquid phase may be required to provide sufficient feed to satisfy the nozzle flow as well as to permit discharge of light phase and clarified heavy phase.

The relatively fine nozzle openings 0.030-0.050 in. dia.) will plug with solids unless an efficient screening operation on the feed effectively removes oversized solids before they can enter the bowl. Also, the sludge discharge has low solids contents (5-20%) due to discharge through the nozzles of large amounts of liquor compared to the amount of solids being removed.

A modification of the standard nozzle-discharge machine recycles a portion of the sludge to increase the total flow through the nozzles, Figs. 7 and 9. At the same time wash liquor can be introduced into the recycle stream.

By recycling, a heavier sludge can be obtained. With a larger flow to handle, nozzle openings can be larger, decreasing chance for plugging.

Another approach to the sludge removal problem is the valve type discharge bowl utilizing a valve that is opened by centrifugal force.

By adding water to the valve assembly, the valve will remain closed. Stopping the water flow by closing the valve in the external water line permits the water in the valve assembly to drain and the valve to open to remove sludge.

By controlling the external water flow to the bowl, the valves are opened at will or on a preset time cycle to provide automatic sludge removal. Relatively high-solids sludges are obtained with this design.

A valve-type sludge-discharging centrifugal, used extensively in Europe, has been introduced recently into the U.S. Called the Titan centrifugal it is manufactured by Titan Corp. of Copenhagen, Denmark, and distributed in the U.S. by the Pitmar Corp. of Baltimore, Md.

This unit is similar to the valve type unit described above, except for one very important difference. The Titan valve has an opening § x 5 in. and the medium sized bowl has 12 such slots. Thus, large particles that might plug small valve parts will readily pass through the valve. Result is claimed to be continuous 24-hr. service without shutdowns for cleanout.

Maintenance—For the standard disk units, without sludge discharge, maintenance or operating labor is consumed in the constant disassembly, cleaning and reassembly of the bowl. When slurry solids concentration is high, on the order of 1%, frequent bowl cleaning limits the application.

Constant handling of the parts may damage the disk stack, the drive parts, etc., requiring more frequent replacement than would be the case for continuous operation.

The valve and nozzle discharge centrifugals go a long way toward eliminating frequent bowl cleanings. On some ideal applications, operation is truly continuous for several weeks.

Maintenance of the valve and nozzle parts may be quite high on abrasive services. The erosive effect of high velocity liquid flows and of the suspended solids requires special abrasion-resistant nozzle materials such as tungsten carbide. Careful assembly of valve parts is critical because a slight leak in the mating joints of the special nozzles and the bowl easily can result in erosion of the relatively soft bowl. Depending on the degree of erosion, a bowl can be damaged beyond satisfactory repair by such a leak.

General maintenance, aside from the points mentioned above, normally is not a large expense item. These units are constructed ruggedly even though they are precision machines. Usually, an occasional bearing or drive gear replacement is all that is required.

Periodic inspection and a strict preventative maintenance schedule pay dividends. Lubricating oil must be checked frequently to be sure it is not contaminated by the process liquors. Loss of lubricating qualities can cause drive gear failures in a very short time because these units rotate at high speed.

### ACKNOWLEDGEMENT

The author acknowledges the contributions of H. F. Porter, J. M. Chalmers and L. R. Elledge of DuPont Engineering Service Div. who assisted in the preparation of this report on centrifugals.

### **Recent Developments**

Operating results with continuous equipment often can be improved by assuring uniformity of feed to the units. Recognizing this fact Baker-Perkins, Inc. now is offering a concentrating screw-feeder for use with the continuous push-type centrifugal.

Slurry is concentrated to uniform consistency in a settling cone, then elevated by a screw feeder to the inlet of the centrifugal. Feed rate to the centrifugal is uniform despite surges in slurry rate and concentration entering the feeder. Output from the feeder varies automatically with changes in the average rate of solids input to the feeder.

Baker Perkins also has integrated the operations of centrifuging and drying. Their continuous push-type centrifugal now can be provided with a dryer mounted directly on the housing. Centrifuged solids are picked up by a blast of hot air and circulated around the inner periphery of the dryer. Air and fine solids discharge through a vortex cone and cyclone collector. The heavier fraction, comprising most of the solids, is trapped and discharged at the vortex cone.

Another line of push-type centrifugals now is available in this country through Cleaver-Brooks Co., Milwaukee, Wis. Included in this line is a relatively new multi-stage design that permits countercurrent washing. Developed for the sugar industry this machine is claimed to perform as well as or better than the vertical basket machines that have been standard in the industry.

A new continuous centrifugal originated in Germany now is being built in this country by Bird Machine Co. It has an inverted cone-shaped, opentop, perforate basket mounted on a vertical axis.

Basket rotates at a comparatively low speed and is oscillated along the axis of rotation by a separate drive. The oscillating motion moves the solids up the inner wall of the basket until they discharge over the upper rim. Liquid passes through the basket into a separate concentric compartment and is removed through an outlet pipe. Speed of rotation and vibration can be varied to satisfy individual applications.

# **Thickeners**

William B. Gery

Gravity sedimentation plays a major role in separating solids from liquids. Working in giant thickeners and clarifiers it removes large tonnages of suspended fine solids from high-volume liquid flows.

To the engineer, sedimentation generally means gravity settling or subsidence of solids suspended in liquids. Corollary to sedimentation are the terms thickening and clarification.

When we talk about thickening, the emphasis is on the solids as the end product of the separation—the compacting of the suspended solids into a dense slurry or sludge in order to facilitate subsequent processing or disposal of the solids.

The term clarification, on the other hand, implies a primary interest in the character or quality of the liquid as the product of a gravity separation in a highly dilute suspension, as in the treatment of a water supply carrying a few hundred parts per million of suspended matter.

Modern era sedimentation dates back to 1906 and the invention of the Dorr Thickener, first mechanicallyequipped, continuous sedimentation unit. From that beginning, progress in the art of thickening and clarification has been measured primarily (1) by increased knowledge and understanding growing from the constant search for ways of promoting and accelerating the work of gravity, (2) by a continuing improvement of the basic designs and construction of mechanisms and (3) by development of special designs and types of machines to keep pace with the expanding scope of applications.

### **Applications**

The widespread applications of thickening and clarification are generally well known. Neither gives an absolute separation of solids from liquids or of liquids from solids.

In many instances, clarification alone affords adequate removal of the solids for all practical purposes. In others, where absolute clarity of the liquid is required, the last traces of suspended matter are removed by filtration through appropriate media in gravity or pressure type filters. This step is sometimes called "polishing."

step is sometimes called "polishing."
Similarly, if the suspended solids are to be completely free of liquid, thickening is generally followed by filtration and drying or calcination. Thus, depending upon product requirements and use, sedimentation may be either the final or an intermediate step in solids-liquid separation.

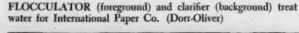
Possibly foremost among the aids to improve sedimentation practice is flocculation in conjunction with the mechanical devices which have been developed to promote and accelerate this physico-chemical phenomenon. Flocculation is practically a prerequisite to efficient clarification in many instances, water treatment being the outstanding example.

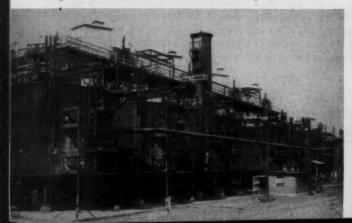
The art of flocculation is old but the science is comparatively new as are the mechanical devices designed to expedite and enhance its effect. Such common flocculating agents as alum and lime were used in water treatment plants long before the advent of mechanisms in settling tanks.

Highly dispersed suspensions cannot be settled and clarified without benefit of a suitable flocculating agent to collect and coagulate the fine, turbidity-producing particles and colloids into settleable clumps or flocs. In many instances where suspensions exhibit inherently good settling qualities, the use of a flocculating agent with mechanical flocculation may increase the settling rate and improve clarification markedly.

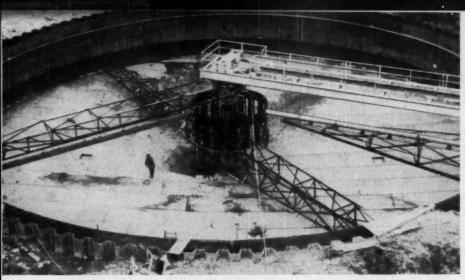
Choice of a unit then becomes a question of economic comparison. The initial cost of the larger sedimentation unit must be balanced against initial and operating costs of the smaller unit. This comparison might well indicate that the cost of auxiliary flocculating equipment and flocculating agent would offset any advantage to be gained using the smaller sedimentation unit. Conventionally, revolving paddles serve as flocculating mechanisms. Their slow rolling motion through the dilute suspension causes the flocs already formed to collect the colloidal and semi-colloidal solids. Speed of paddle rotation is insufficient to shear the flocs, yet fast enough to insure maximum opportunity for particle collision and adhesion.

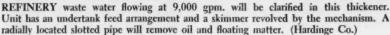
TRAY THICKENERS in plant of The Aluminum Ore Co. separate red mud from sodium aluminate liquor. (Dorr-Oliver)

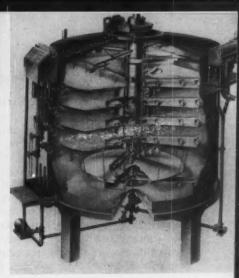












CLARIFIER handles parallel flows of flocculated sugar-cane juice in four compartments. (Dorr-Oliver)

An important contribution to processing which sprang from the basic unit operation of sedimentation is continuous counter-current decantation, commonly called CCD. Although first developed in the metallurgical field, it now is widely used also in chemical processing. With CCD fine insoluble solids are washed free of liquid containing dissolved values or impurities by repeated thickening and decantation in a series of sedimentation units called thickeners.

Wet classification, or separation of particles into fractions according to size, shape or specific gravity, is another common adaptation of the gravity sedimentation principle. Hydroseparation is a variant form of classification which is rather loosely interpreted as water-floated size separations of solids in the range of finer sizes at relatively high dilutions.

### **Basic Sedimentation Equipment**

Basically, a thickener comprises a shallow, cylindrical tank with a sloping bottom and a slowly rotating raking mechanism to sweep the settled solids to the central discharge opening. A peripheral overflow launder or collecting trough is located just below the top of the tank to remove the clarified liquid or effluent.

Conventionally, a centrally located circular feedwell at the surface directs the incoming feed downward into the tank and should be designed to minimize short-circuiting to the overflow launder. Settled solids are pumped from a central sludge well.

Present day commercial thickeners range in size from about 8 ft. to 325 ft. diameter with depths of a few feet in the very small diameters to 25 ft. or more in the very large units.

Raking mechanisms are supported in either of two ways. Generally, in units up to 60 ft. diameter I-beams or trusses, spanning the tank, constitute the support. In larger units the mechanisms are usually carried on central piers of steel or concrete construction.

The simpler raking mechanisms consist of two radial arms, 180° apart, with blades attached to rake the solids toward the central discharge cone. The rake arms, in turn, are attached

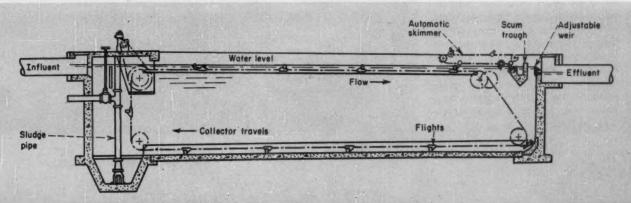
to a central shaft or cage. Variations include three- or four-am mechanisms for certain heavy duties and continuous double spiral scrapers.

Drive mechanisms are usually centrally located at the upper end of the central shaft or mounted on a turntable, depending on the type of unit. For very large diameters, mechanisms with traction drives at the periphery of the tank are sometimes used.

Several types of overload protection are also available, from simple manually operated lifting devices for the smaller diameters to a variety of automatic designs. These devices are designed to raise the raking mechanism a foot or more in the event of sludge overloads. When the overload has been reduced or relieved the raking mechanism is lowered to its normal operating position.

In widely scattered, small tonnage operations, sedimentation is still carried out sometimes in simple batch tanks without mechanisms, operating intermittently. After filling and allowing sufficient time for the suspended solids to settle and thicken, the su-

RECTANGULAR settling tanks recover sludge at industrial water and waste treatment plants. Sludge is collected by chain-mounted scraper or drag that moves along tank bottom. Skimmer is used on primary settling operations. (Link-Belt)



pernatant liquid is withdrawn through pipes or siphons, the solids pumped or sluiced out, and the process repeated.

In a comparatively few instances, continuous settling cones are probably still being used. Originally developed for intermittent use, such cones on occasion have been adapted to continuous operation. However, the use of plain settling tanks today is largely confined to very small operations with intermittent flows.

### Thickener Variations

Multiple compartment or tray thickeners were developed relatively early to provide maximum settling area in a minimum floor space, usually comprise no more than six compartments superimposed one upon the other.

These units have widespread application in beet and cane sugar processing, pulp mill recausticizing systems, and in the aluminum industry. They may be arranged to operate with all compartments in parallel to simulate a number of individual units, in series to provide several stages of countercurrent washing, or in a combination series-parallel pattern.

The hydroseparator, though in reality a classification device, is basically similar to a thickener in construction and operation. The tank is sized to provide the settling area necessary to recover a coarse fraction-those particles preponderantly larger in size than the desired mesh of separation -and is insufficient in area to retain the smaller particles. It is particularly applicable to classification work in the 43 to 150 micron range; also where preceding steps impose the need for handling very large flows as in some of the large washing plants of the phosphate and coal industries.

### Square and Rectangular Clarifiers

Minimum requirements governing the design and construction of mechanisms for thickening applications are, as a rule, greater and more critical than for clarification. Thickener tanks are almost invariably round. From the standpoint of design and engineering the more rugged, heavier-duty mechanism is much better adapted to a round tank than to a square or rectangular tank. On the other hand, in clarification work, such as certain trade wastes, sewage and water treatment, the lighter and finer solids and the more dilute resultant sludges usually encountered permit the use of comparatively lighter mechanisms. Mechanisms for this type of duty are easily adaptable to round tanks and quite as readily to square and rectangular tanks. Such installations are commonly called clarifiers.

Square mechanisms are basically similar to those installed in round tanks except for the addition of supplementary hinged rake arms to sweep sludge from the corners into the path of the two main circular raking arms. Units of this type may be fed either through a central feedwell as in round clarifiers or along one side wall, so that feed flows across the tank (crossflow type) and overflows a weir along the opposite wall.

Rectangular tanks use an entirely different type of mechanism, commonly called a "drag." Operation is again cross-flow, across the longer dimension. Settled solids are raked to a sludge well at one end of the basin by a series of scrapers extending the width of the tank.

Major difference in equipment of this type is the method of driving the scrapers. In "chain-type" units, the scrapers are attached to two parallel endless chains driven by a stationary motor located at one end of the tank. Scrapers on "bridge-type" mechanisms are suspended from a bridge traveling on rails mounted on the side walls.

The driving mechanism may be stationary and draw the bridge to and fro by traction ropes, or it may be carried on the bridge. In either case, an arrangement of electric switches is employed to reverse the direction of travel at the ends of the tank.

### **Combination Units**

Combination units, developed primarily for water and waste treatment but also applicable to chemical processing, incorporate in a single, compact machine two or more of the unit operations of mixing, flocculation, clarification and thickening.

In the chemical industry the mostwidely used unit flocculates or coagulates particles in a central compartment and settles the flocculated solids in an annular chamber. Chemicals to aid coagulation usually are mixed with the feed before it enters the unit. Vertical paddles in the central compartment gently promote flocculation.

Two major sewage-treatment combination units provide in one case for aerating sewage in an annular compartment surrounding a clarification chamber and in the other for clarifying in an upper compartment located above a sludge digestion chamber.

Water treatment has, without a doubt, provided the most fertile grounds for the development of combination units. Often referred to as vertical-flow or high-rate machines, these units are designed primarily to

COMBINATION of two 225-ft. thickeners and a 30-ft. hydroseparator (left foreground) can handle 4 million tons of flotation tailings per year to recover the maximum quantity of water. Hydroseparator scalps out coarse oversize. (Dorr-Oliver)



remove hardness, color and turbidity. Any necessary treating chemicals such as lime, soda ash and often activated silica, may be introduced in a small exterior mixing tank or added directly to the reaction or sludge zone.

All units of this general type perform the same basic functions. However, manufacturers have varied the design extensively and have incorporated compartments, rake arms, and even small agitators to implement the four unit operations of mixing, flocculation, thickening and clarification.

In all high rate units treated water flows upward through a suspended sludge blanket and overflows a peripheral weir. Operational variations occur chiefly in methods of feeding, removing sludge, and mixing before flocculation.

A new combination unit recently developed primarily for water treatment incorporates a mechanical pretreatment mechanism and an annular rapid sand filter in a single compact installation. It is applicable to the requirements of both municipalities and industries in the range of 0.2 to 20 million gal. of treated water daily and lends itself readily to automatic instrument-controlled operation. Depending upon the characteristics of the raw water, there is a choice of three pre-treatment mechanisms. Ordinarily a high-rate upflow mechanism will be employed, but under certain conditions either a combination flocculation-clarification unit or a plain clarifier may be recommended.

### **Auxiliary Equipment**

Customary auxiliaries for sedimentation units include pumps to remove the underflow solids and time clocks to control periodic pumping should the sludge volume be insufficient for continuous operation. As previously mentioned, lifting devices to protect the mechanisms under abnormal load

conditions are also available. These usually operate in conjunction with torque recorders and overload alarms which indicate visually and audibly the reactions of the mechanism to the load.

Another auxiliary is a system of vertical pickets on the rake arms. These vertical members, readily built into the rake assembly, are a proven means of producing thicker sludges with certain types of pulps. Resembling fence pickets, the stirrers pass gently through the lower thickening zones to rearrange and channel the solids, thereby promoting upward release of occluded water which would otherwise be trapped in the underflow.

### Design Criteria

General design of sedimentation tanks does not, for the most part, follow strict geometric proportions. The depth to diameter relationship is significant only to the extent that the projected tank volume will provide the requisite minimum detention or holding time, taking into account efficiency and mechanism design factors. The design and size proportions of feedwells, on the other hand, can be quite critical in affecting the performance of sedimentation units, clarifiers in particular.

Capacity is essentially a function of the settling characteristics of the solids which, in turn, involve a number of factors: particle size and distribution; shape, specific gravity and flocculence of the solids; specific gravity and viscosity of the liquid; liquid to solids ratio and temperature. Other factors which may affect capacity in varying degrees are: design of feeding arrangements, speed of the mechanism, convection currents and, in some locations, wind disturbance and evaporation in large-diameter uncovered tanks.

Settling characteristics of solids of the same composition but of a different origin may vary greatly. For example, magnesium hydroxide precipitated from brine requires from 60 to 100 sq. ft. of thickening area per ton of solids (dry basis) per day, while magnesium hydroxide precipitated from sea water requires from three to five times as much area.

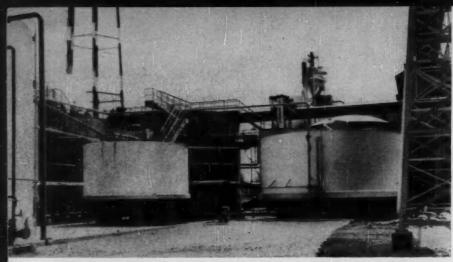
Generally, metallurgical pulps settle faster and require lower unit areas

Table I-Thickener Unit Area Required for Various Pulps

Type of Pulp	Feed % Solids	Underflow % Solids	Unit Area, Ft.2/Ton/24 Hr.
Copper flotation concentrates	14-50	40-75	3-20
Beet sugar mud	3-8	17-22	4-20
Cyanide process slimes	16-33	40-55	5-13
Recausticizing lime mud	8-10	32-40	14-18
Cement slurry	16-20	60-70	15-25
Lime-soda process carbonate mud	9-11	35-45	15-25
Water floated calcium carbonate	3-5	30-50	47-75
Water floated clay	1-4	15-45	50-225
Magnesium hydroxide produced from brine	8-10	25-50	60-100
Magnesium hydroxide produced from seawater	0.3-0.6	11-22	200-500
Titanium dioxide	10-20	40-45	60-110
Bauxite residue after sulfuric acid digestion	5-9	20-30	75-150

MILL waste from paper machine and general wash-up water is clarified in Type SS 300-ft. dia. clarifier installed in a 500-ft. earthen basin. Using sea water as a flocculent 90% of suspended solids are removed and B.O.D. drops 33%. (Dorr-Oliver)





GREEN liquor clarifier and dregs washer for recausticizing system at the Voldosta, Ga., mill of National Container Corp. Built with new unit-compartment design each unit is served by one mechanism and equipped with special feedwell. (Dorr-Oliver)

H<sub>0</sub>
H<sub>1</sub>
H<sub>2</sub>
H<sub>U</sub>
Time, days

GRAPHICAL approach speeds up determination of thickener unit areas. Shows pulp height vs. time for settling test.

than pulps of chemical origin. Particle size and specific gravity usually account for the difference. Table I, while being far from a complete list, shows the range of unit areas for some typical thickener applications.

Standard materials of construction for mechanisms are usually iron and steel. Designs utilizing special materials such as stainless steel, bronze, wood and rubber or lead covering are available where required. Tanks may be of mild steel, concrete, or wood, and rubber or lead lined.

In certain types of applications, and more particularly for very large industrial installations clarifying plant wastes for recovery of water, earthen basins have become increasingly popular because of their lower installed cost. Among such units installed to date are a 300-ft. mechanism in a 750-ft. diameter earthen basin to clarify 15,000 gpm. of phosphate rock slimes tailings water, a 300-ft. diameter mechanism in a 500-ft. basin removing 90% of the suspended solids from pulp mill effluent, and three 250-ft. thickeners aligned in a 775 x 275-ft. basin to recover 14-15 million gal. of water daily in a silica sand washing plant.

Table II
Cost Estimates for Concrete-Basin,
Single-Compartment Thickeners

Thickener Diameter, Ft.		Cost, \$ per Ft. <sup>2</sup> Settling Area
24-35		17-26
35-40		14-18
40-50		12-15
50-60	*	11-13
60-70		10-12
70-80		9-11
80-90		9-10
90-100		8-10

### **Equipment Costs**

Costs of complete installations are subject to so many variables even when prices are stable that it is practically impossible to arrive at a dependable factor of unit costs. Mechanism costs in themselves can vary widely for any given diameter depending upon the type of construction. However, the delivered price of mechanisms of standard design and construction at the present time will probably represent on the average from 20 to 30% of the total cost of the installation.

Shown in Table II are rough unit cost estimates based on single-compartment thickeners of standard construction in concrete tanks in a range of diameters from 24 to 100 ft. These estimates cover complete, ready-to-operate units and include excavation and back-fill, tank construction, all mechanical equipment, supports, weirs, erection of mechanism and wiring.

The unit cost of thickeners in diameters less than 24 ft. increases rapidly with decreasing diameters and may well reach \$50-\$75 per sq. ft. of area at 10 ft. Above 100-ft. diameter the cost per unit of area decreases very little.

If a clarifier rather than a thickener mechanism is employed, installed cost is reduced 3 to 8%. Similarly, heavy-duty mechanisms will increase costs by approximately the same amount. Special mechanisms and tanks will increase the estimated unit costs substantially.

The initial cost of a steel tank with substructure may run appreciably less

than for concrete in diameters up to about 80 ft., but the cost of maintaining and painting steel tanks may offset any initial advantage over the years.

### **Operating Costs**

Power consumption of clarifiers and thickeners is a small item indeed, as indicated in Table III. Power requirements of clarifiers run even less than for thickeners of the same diameter.

On the whole, repair, maintenance and operating labor costs are comparatively modest, due to the very slow speeds of the mechanism and the absence of submerged machine parts and bearings.

Over-all operating costs for metallurgical thickeners handling large daily tonnages of solids rarely exceed 5¢ per ton; generally range from 1 to 5¢ depending upon the size of the operation.

### Thickening Tests Simplified

In the early days of continuous sedimentation, a method was developed to predict from a series of laboratory batch tests the thickener area required by various materials. It involved settling tests on pulp at various dilutions ranging from a point

Table III

Motor Horsepower and Rake Speed of
Typical Unit-Compartment
Thickeners

Tank Diameter, Ft.	Drive Motor, Hp.	Rake Speed, Min./Rev.
20	1	4
60	2	10
100	3	13
150	5	19
200	734	23

well above normal feed dilution to well below compression—the point where solids are no longer free settling. In addition, a so-called final density test was run to determine the extent to which the solids could be thickened.

Unit areas were then calculated using the settling rates, corresponding pulp dilutions, and final dilution as derived from the tests. Thickener diameter was based upon the maximum unit area.

This method was employed without significant alteration for almost 35 years until a new and simplified means was developed recently. It is now necessary to run but one batch test starting with a relatively dilute pulp and continuing through compression to final concentration.

The pulp depth at various times is plotted graphically against the time required to attain that depth. A tangent to this plot is drawn at the point of compression. The intersection of this tangent and the line representing final pulp dilution determines the time  $(t_u)$  required to attain ultimate density.

Maximum unit area may then be calculated by substituting in the formula U.  $A = t_u/C_0H_0$  this graphically-determined  $(t_u)$ , pulp depth  $(H_0)$  and concentration  $(C_0)$  at the start of the test. Unit area is expressed in sq. ft. per ton of solids per day, time in days, pulp depth in feet, and concentration in tons per cu. ft.

The new method eliminates as many as fifteen batch tests and has proven to be as accurate as the original method in dilute zones and more reliable in zones of greater concentration. Comparison of actual thickener unit areas and those predicted as outlined have checked very closely in four western beet-sugar plants.

### New Developments

For the most part, equipment design has been relatively stable since the early days of continuous sedimentation with improvements limited chiefly to driving mechanisms. Major exception has been the recent redesign of the green-liquor clarifier and dregs washer in the pulp and paper chemical-reclaiming system. The four-compartment tray machines formerly used at both points in the flowsheet have been replaced by unit-compartment

clarifiers of new design equipped with special feedwells.

Tray units, while producing overflows of acceptable clarity at low rates, did not fully utilize existing tank volume. Feed was short-circuiting, streaming from the rather shallow feedwell to the overflow weir. Thus green liquor was detained only a fraction of the desired time.

A survey of a number of recausticizing systems indicated that short-circuiting could be minimized by designing clarifiers with a depth to diameter ratio greater than conventional and a larger diameter and deeper feedwell. Unclarified new feed then can be introduced well down in the tank at a point where solids concentration is more nearly equal to feed concentration—a condition which assures maximum flocculation of solids in suspension and better clarification.

This same survey also revealed a relationship between detention time and overflow rate of the liquor. Formerly, it had been thought that overflow rate was the primary factor affecting overflow clarity. These tests clearly pointed up the fact that by providing sufficient detention time, overflow rates could be radically increased without impairing clarity. To produce the best overflow at a minimum investment cost, design of the clarifier hinges on the establishment of an optimum relationship between overflow rate and detention time.

For green liquor this optimum relationship permits use of a single-compartment clarifier, somewhat deeper than conventional and equipped with a large, deep feedwell, to boost the overflow rates three or four fold with no sacrifice in overflow clarity. This unit compartment design now has

been incorporated into the standard recausticizing system for both the dregs washer and the green-liquor clarifier.

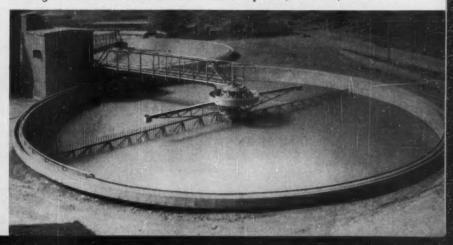
Equipment redesign, however, has not been limited to the pulp and paper industry. In the metallurgical field, thickeners of special unit-compartment design have been applied to the clarification and thickening of blast-furnace flue dust and, to date, results have been excellent.

With extremely deep units, overflow rates have been increased four to six fold and overflow clarities simultaneously have been substantially improved. It is expected that operating results from shallower units, now being erected, will also show marked, but not as spectacular, improvement.

The chemical industry also has been affected by this change and unit-compartment clarifiers of this general design are presently going into operation. Should these applications prove as successful as those mentioned above, clarifiers of the new unit-compartment design may well be applied to many chemical problems formerly served by tray units.

For a number of years equipment manufacturers have experimented with several different methods of producing a thicker underflow. Vertical pickets have probably been the most successful of these devices, but they have increased underflow density of some solids only a few percent in most cases. More recently, however, other types of mechanisms have been utilized in experimental work. In the near future more dense pulps-which may be unpumpable and removable only by screw conveyor-may become a reality rather than just a gleam in the manufacturer's eye.

PICKETS on rake assembly pass through sludge blanket to rearrange solid particles, releasing occluded water at Missouri Portland Cement plant. (Dorr-Oliver)



# Wet Cyclones o. F. Tangel and R. J. Brison

Wet cyclones are used mainly for classifying in the 5-150 micron range, but can also serve for thickening if fines recovery is unimportant. They are making rapid gains in both mineral and chemical processing.

Although the dry cyclone has long been used for separation of fine particles from air and other gases, the wet cyclone, or solids-liquid cyclone, is a relatively new tool in the fields of classifying and dewatering. It was first used commercially by the Dutch States Mines in Holland, just prior to World War II, and its development was continued in Holland during the war. In recent years, the cyclone has been rapidly gaining popularity in the mining, minerals processing, and chemical processing fields. Its use should be considered whenever it is desired to make a size separation in the range from 5 to 150 microns, or for dewatering when recovery of fines is not important. Where it is applicable, the cyclone offers the advantage of high capacity for the space required and moderately low initial cost.

The cyclone consists mainly of a short cylindrical section as in Fig. 1, mounted on an inverted conical section. The feed is pumped at high velocity through an orifice tangential to the cylinder wall, resulting in a high centrifugal force within, the cyclone. The coarser and denser particles are thrown rapidly outward to the wall of the cyclone where they are carried in a spiral course to an opening at the apex of the cone. The remaining particles, and the bulk of the liquid move inward and follow a reverse spiral course near the axis of the cyclone and are discharged through a tube known as the "vortex finder." A cylindrical air core normally occupies the space at the axis of the cyclone. The two-spiral concept is admitedly an oversimplification of the flow pattern, but it provides a convenient way to visualize the general motion within the cyclone. Several authors1-8 have discussed in detail the nature of the flow in the cyclone.

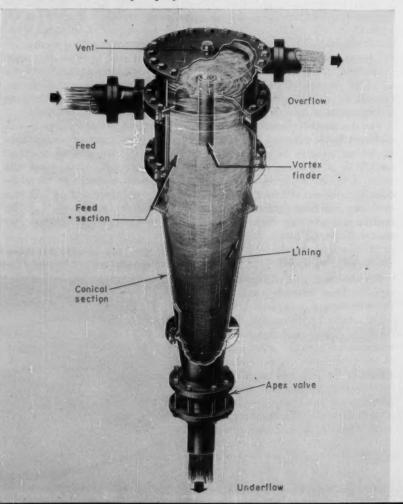
The material discharged at the apex is usually termed the underflow, and

that discharged through the vortex finder is termed the overflow. However, the terms underflow and overflow are not related to the fact that the cyclone is usually operated in a vertical position with the vortex finder on top; in fact, except for large cyclones operating at low pressures, the centrifugal force involved is so great compared to the force of gravity that the cyclone can be operated in any position.

The main action in the cyclone is one of classification, as opposed to thickening. For effective thickening, it is desirable to cause the fine particles to form flocs or agglomerates which have much higher settling rates than the individual particles. In the cyclone, flocculation does not occur for two reasons: (1) The large shear forces caused by differences in tangential velocities quickly break up any existing flocs and prevent formation of new ones. (2) The centrifugal force on the particles is so much greater than the inter-particle forces that flocs cannot form during the brief residence time in the cyclone.

However, the same characteristic which makes the cyclone a poor thick-

Fig. 1—Cutaway view of a conventional 24-in. DorrClone cyclone showing simple construction and relation of principal parts. (Dorr-Oliver)



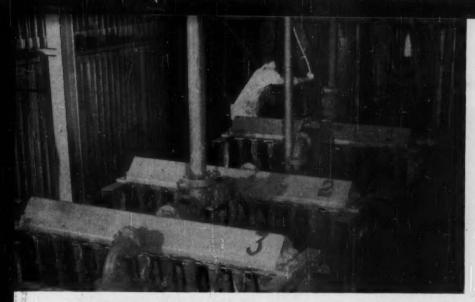


Fig. 2-This installation, for wash water recovery in coal cleaning, has five 14-in. cyclones and five 22-tube manifolds of 3-in. cyclones. (Heyl & Patterson)

ener enhances its effectiveness as a classifier. For good classification, dispersion of particles is a prerequisite, and this can be accomplished in the cyclone without the necessity of adding chemical dispersing agents, as frequently required in gravity classifiers. It is therefore apparent that the main field of application is in classification rather than thickening, and will be so considered here.

### Operating and Design Variables

In any classification operation there are certain conditions determined by the existing or proposed process. These include:

- 1. Volume of material treated.
- 2. Percentage of solids or dilution.
- 3. Size distribution of solids.
- 4. Specific gravity of solids and liquid.
  - 5. Viscosity of the liquid.
- 6. Size of separation and accuracy of separation required.

Although most of these conditions are usually fixed, they have a definite bearing on selection and operation of a cyclone. The dilution can often be controlled to some extent, and it has been found generally desirable to have a water-to-solids ratio of at least 8 to 1 for effective separation."

In the design and operation of the cyclone, there are a large number of controllable variables, but only those which are considered to be most important will be discussed. These are:

- 1. Diameter of the cyclone.
- 2. Size of feed and discharge open-
  - 3. Feed pressure.

Contrary to the general rule in processing equipment, the size of the cyclone is not determined primarily by the required capacity, but rather by the desired size of separation. Because of the greater centrifugal force, separations are obtainable at a finer size in small-diameter cyclones than in large units. For example, 3-in. cyclones (Fig. 2) will classify in the 5-20 micron range while cyclones 10 to 15 mm, in diameter are used for separations in the 2 to 20 micron range. In contrast, 24-in. cyclones make separations in the neighborhood of 100 to 150 microns. In the case of the smaller units, several cyclones are normally operated in parallel (Figs. 2 and 5) from a common manifold to provide the required capacity.

Once the cyclone has been selected, the main control over the size of separation is in the diameter of the feed entrance and the vortex finder tube. In general, the smaller the openings, the finer the size of separation obtained, but if the orifices are reduced in size beyond a critical point, the separation again becomes coarser. According to Fitch and Johnson, for minimum size of separation in any given size of cyclone, the feed entrance and vortex finder usually have equivalent diameters in the range of 1 to 1 the diameter of the cyclone, but this may vary with the nature of the feed. It is desirable to have replaceable or adjustable feed entrances and vortex finder tubes, particularly in the case of new applications.

The apex discharge orifice is perhaps the most critical of the operating variables, especially if maximum effi-

ciency of separation is required or if large fluctuations occur in the feed. If this opening is too large, the underflow will contain a considerable amount of liquid. Since this liquid will contain proportionately as much of the finest particles as the overflow liquid, the underflow product may be contaminated with an undesirable amount of fine particles.

To avoid this, the underflow discharge orifice should be as small as possible. But, if too small, it may prevent discharge of the coarse solids as fast as they reach the apex, with the result that some of the coarse particles are forced out the overflow. The appearance of the underflow discharge shows whether this condition exists. In normal operation, the discharge is in the form of an inverted funnelshaped spray, but if the opening is small enough to cause the overloaded condition, the underflow is extruded in a thick ribbon somewhat resembling a rope or sausage in appearance.

Various types of interchangeable orifices and manual controls for changing the orifice diameter during operation have been used: An ingenious automatic control<sup>®</sup> has been devised by utilizing the observation that, near the apex of the cyclone, the central air core is under reduced pressure in normal operation, while the pressure is a function of the underflow density. This device is reported to give close control over the underflow density in spite of large fluctuations in the feed.

The pressure at which the feed is supplied to the cyclone affects the operation in several ways. Increased pressure permits increased throughput, hence, higher capacity. The increased velocity causes higher centrifugal force within the cyclone, which tends to decrease the size of separation. However, this effect is partly offset by the shorter residence time in the cyclone. The disadvantage of high pressures, apart from higher pumping costs, is that it causes greater wear. Pressures normally employed range from about 10 psi. for the largest cyclones to 100 psi. or more for the smallest sizes. Work has been done in France<sup>10</sup> on gravity-fed cyclones employing feed pressures of less than 7 psi., but more work remains to be done to determine if such cyclones have commercial applications.

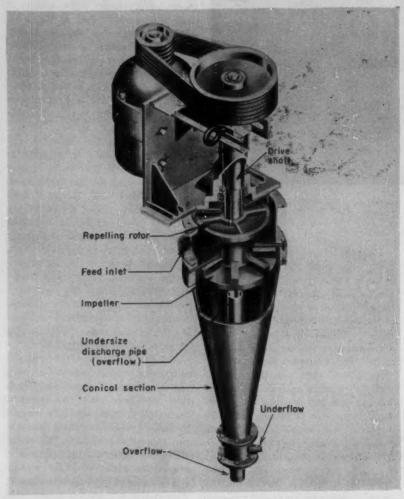
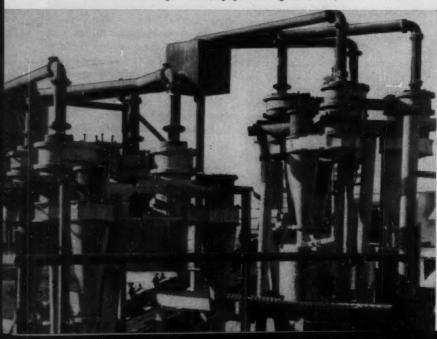


Fig. 3—Cutaway view of Centriclone-type impeller-operated liquid cyclone. Slurry velocity is imparted by an internal impeller, rather than by pump pressure and tangential inlet as in conventional cyclones. (Dorr-Oliver)

Fig. 4—Group of eight Model EE Krebs two-stage liquid cyclones working on silica glass sand in California. The cylindrical first stage of each unit discharges to a smaller conical second stage unit. (Equipment Engineers, Inc.)



### Cyclone Variations

Various modifications in the design of the cyclone have been introduced. One type of unit called the Centricione, shown in Fig. 3, is equipped with a motor-driven impeller in the cylindrical section and does not require an auxiliary pump. This design is reported to be especially suited for sharp classification of thick pulps.

Another variation, the Krebs Cyclone, is a two-stage arrangement (Fig. 4) in which the primary separation is made in a cylindrical "cyclone," the underflow being discharged tangentially and fed directly into a smaller secondary cyclone of conventional design. The overflow from the secondary cyclone can be recycled if desired.

A modification described by Herkenhoff<sup>11</sup> involves essentially replacing the standard vortex finder tube with two concentric tubes. The discharge through the inner tube is unrestricted, but the discharge through the outer tube is regulated by means of a valve in the conduit which carries the product away from the cyclone. The principal advantage claimed for this arrangement is that it provides a simple external control over the operation of the cyclone.

Dahlstrom<sup>12</sup> has shown that the amount of undesirable fine material in the underflow can be reduced by tangential injection of water near the apex of the cyclone, and commercial units (made by Heyl & Patterson) are available with this feature.

Not all the modifications of the basic cyclone have been in the direction of more complexity. In at least one plant, cyclones have been made from standard pipe and flanged reducers. In other cases, a straight piece of pipe has been used, with a tangential feed entrance and vortex finder at one end and a cap with a central orifice at the other end.

Emmet and Dahlstrom<sup>18</sup> have described a 30-in. diameter open-top cyclone for classification at sizes coarser than 150 mesh. This cyclone is fed by gravity through a tangential feed entrance, and the centrifugal force involved is relatively low.

For ultra-fine separations in the range from 2 to 20 microns, the Type TM units made by Dorr-Oliver, Inc., consist of 24 or 32 miniature cyclones

installed in a common housing, and operating in parallel, with provisions for introducing the feed and withdrawing the products. These cyclones are 10 and 15 mm. in diameter, one type (Fig. 5) with individual Bakelite cyclone tubes, the other with the tubes cast en bloc in rubber.

### Designs of Installation

Because so many factors influence the operation, no satisfactory formulas have yet been reported to permit direct calculation of the design of a cyclone installation for a particular job. Considerable detailed data are available on the performance of the cyclone in a variety of applications, but in each case the data apply only to a particular set of circumstances and variables. Selection of a cyclone for a new application is largely a matter of judgment based on knowledge of previous applications and an understanding of the variables involved. The following information abstracted from data of one manufacturer will give some indication of the performance of various size units:

Cyclone	Nominal Capacity	Nominal
Diam.,	per Unit,	Classification
Inches	Gpm. @ Psi.	Size Range
3	10 @ 40	5-20 microns
8	100 @ 30	20-40 microns
14	230 @ 30	100-325 microns
24	1,000 @ 20	Coarse sep. or scalping

Because it is not yet possible to predict accurately how a given cyclone will perform in a new application, it is desirable either to have tests made on a commercial-size cyclone at the manufacturer's laboratory, or to install a cyclone at the plant on an experimental basis before proceeding with a large-scale installation.

In a typical cyclone installation, the cyclone itself requires a relatively small space, and can be installed in places too small for other types of classification or thickening equipment. However, the installation should be made in such a way that the cyclone is readily accessible when maintenance is necessary.

The auxiliary equipment required for the cyclone will vary with individual cases. The main item is usually the pump which will, of course, be selected on the basis of the capacity



Fig. 5—Assembly of Bakelite tubes for a Type-TM DorrClone unit, with casing removed. The 32 tubes are 10 mm. in diameter, operate in parallel. (Dorr-Oliver)

of the cyclone installation, the pressure required for operation of the cyclone, and the characteristics of the material being handled. If appreciable fluctuations occur in the feed, this should be remedied by placing an adequate surge tank ahead of the pump, or by recirculating part of the cyclone overflow to provide a constant volume of feed.

### Maintenance of Cyclones

In many cyclone installations, excessive wear on the cyclone has been a serious problem, particularly at and near the apex discharge and the feed entrance. Wear is especially severe when handling coarse abrasive materials. This problem has been discussed in some detail by Fischer and Forger. Various types of wear-resistant construction materials have therefore been tested.

Usually it is desirable to use replaceable wear-resistant inserts in sections of greatest wear. In most cases, soft-rubber parts give the longest life, usually a year or more. Ni-Hard inserts usually have a life of several months, and are more economical in some instances. In a coal-washing application, liners of ceramically bonded abrasion-resistant material were found to be most satisfactory. Since feed pressure affects the rate of wear in a

cyclone, the possibility of operating at a lower pressure should be considered in cases of excessive wear. If the feed contains much coarse, abrasive material, it may be advantageous to scalp out the coarsest fraction with a large cyclone or possibly by some other means.

For problems requiring heat and corrosion-resistant materials, cast porcelain cyclones are now made in a 50-mm, diameter size.

One of the attractive features of the cyclone as a classifier or thickener is its low initial cost, even including the cost of the auxiliary equipment and installation. However, because of the rather severe wear and the power required for pumping, the operating cost for the cyclone is generally higher than it would be for gravity classifiers and thickeners.

### How Cyclones Are Used

Classification—As has been pointed out, the cyclone is inherently a classifying device. It can make separations as coarse as 100 mesh, or as fine as 2 microns in some special cases.

Cyclones are rapidly gaining favor as classifiers in closed circuit grinding, especially where grinding to a fine size is required as in cement mills, cyanidation mills, and flotation plant regrind circuits. In iron-ore grinding circuits,

cyclones have the added advantage that they minimize difficulties due to magnetic flocculation, and full-scale installations are being made.

They have been found effective for desliming ground ore prior to flotation. tabling, and other concentration processes in which the slime fraction is detrimental. Cyclones are used in the mining field also for desliming mill tailings to improve the drainage characteristics, thereby making the tailings suitable for mine backfill and for construction of dams for tailings ponds.

Other applications include removing undesirable minus 200-mesh fines from glass sand, recovering and classifying sand to be used for construction, classifying bentonite and pumice slurries at 10 microns, and degritting clay slurries, slaked lime, and whiting.

In the manufacture of evaporated salt, cyclones have been used to classify the sodium chloride slurry at about 200 mesh, the overflow fraction being returned to the evaporator for further crystal growth.

In the pulp and paper industry,15 cyclones of several makers are used for removal of undesirable coarse and heavy particles from dilute pulps.

Impurities in food industry products are removed from corn and potato starch by groups of 15-mm. diameter cyclones.\* Cyclones are reported to be effective also in separating the kernels from the shells of palm nuts.

Thickening—Cyclones are generally unsatisfactory as thickeners because the intense shear forces and the centrifugal force prevent flocculation which is a prerequisite in thickening of fine suspensions. However, because of their other attractive features, they are sometimes used as thickeners in cases where either (1) the material has been previously classified to remove the finest fraction or (2) the loss of fine solids in the overflow is not objectionable.

When cyclones are used as thickeners and high recovery of solids is required, small-diameter cyclones with small orifices are recommended. The feed pressure should be high, and the underflow rather dilute, if possible.

The prime example of the cyclone as a thickener is in coal preparation (Fig. 2) where it is used to make possible a closed water circuit. The washery water which formerly contaminated streams is now treated by cyclones to recover the fine coal, and the cyclone overflow is clean enough for reuse in the washery.

Other closed circuit applications are recovery of solids from water used to scrub flue gas, and cleaning of wash water used in wet screening.

Specific-Gravity Separations-In addition to its applications for classifying and thickening, the cyclone has been found useful for separation of minerals on the basis of specific gravity by employing a suspension having a density greater than that of water. The well known heavy-media separation process is not generally effective in the treatment of particles finer than about 10 mesh when the separation is made in conventional equipment under the force of gravity. However, utilization of the high centrifugal force in the cyclone has made possible separations of particles as fine as 65 mesh.

The operating principles of the cyclone when used for this purpose are basically the same as when it is used as a classifier, with additional variables involving the medium. Magnetite is the most generally satisfactory material for cyclone separations up to about 3.0 specific gravity; ferrosilicon would be suitable for higher density separations. Both can easily be recovered by magnetic methods. Clay, sand, shale, or similar locally available inexpensive materials can be used for separations at densities from 1.0 to about 1.3.

Because of the high centrifugal force in the cyclone, the particles used to make the suspension must be finely ground, for example, about 70 or 80% minus 325 mesh. If too coarse, the particles will settle too rapidly; if too fine, the viscosity of the medium may be too great for effective separation.

The specific gravity of the medium largely controls the effective specific gravity of the separation. However, it should be noted that the actual separation normally takes place at a somewhat higher specific gravity than that of the medium fed to the cyclone. This is because the particles of the medium are retained in the cyclone longer than the fluid, and the density of the medium in the separating zone

in the cyclone is, therefore, greater than that of the medium fed to the

This effect of a buildup of the particles in a cyclone has been used experimentally in Holland<sup>5</sup> to separate coal from shale in the size range of 0 to 75 microns without any added medium. The fine particles of shale build up within the cyclone and form a suspension with an effective specific gravity greater than that of coal, A cyclone has been designed which is claimed to be particularly effective in making separations of this type.

In the past five years, cyclone heavymedia separation, using magnetite medium, has become a major process for concentration of Lake Superior iron ores at 4 in. to 65 mesh.

In the coal preparation field, most of the pioneering work has been done in Europe, where both slate and magnetite have been used as media.36 Recent developments in this field include the use of cyclones operated at low pressures to minimize wear.

A notable feature of such plants, particularly in the case of iron ore, is the relatively small size of the cyclone installation itself compared to the associated equipment. The cost of operating the cyclone itself may be of minor importance, even though it is the hub of the process.

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# **How to Estimate Stack Costs**

Brick, concrete and steel stacks their materials of construction, amounts required, prices asked — all you need to

### E. J. STANKIEWICZ

quickly figure initial costs.

Complete, accurate costs of stacks are influenced by many factors and will vary from one installation to another. However, if we know the amounts of the materials that go into stack construction and apply current unit prices to these materials we can determine the comparative initial costs of the stacks.

This paper presents, in a series of graphs, the material requirements for steel, brick and concrete stacks-their supports, foundations and linings. And it lists current price ranges for these materials.

### **Brick Stacks**

Material quantities\* for determining estimated costs of radial brick stacks can be obtained from Figs. 1 to 3.

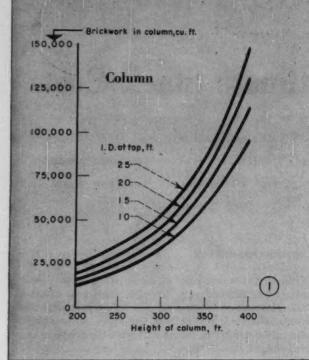
Fig. 1 gives the volume of radial brickwork for stack columns. The unit cost per cubic foot of radial brickwork ranges from \$1.90 to \$3.50. This includes mortar, step irons, cast aluminum air vents at top and bottom of each lining section, concealed steel reinforcing bands, cleanout door, lintels above breeching and cleanout doors. The unit cost does not include steel breeching frames, bronze rail for obstruction lighting, lightning protection system

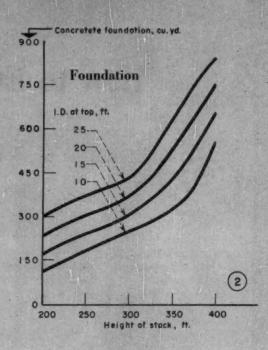
E. J. STANKIEWICZ is chief structural engineer for Sargent & Lundy, Chicago, Ill., as well as a partner in the firm. A civil engineering graduate of the University of Illinois, with nearly thirty years of engineering experience, he has worked for Koppers Construction Co., Pittsburgh, Elwin E. Seelye, Consulting Engineers, New York City, and the Commonwealth & Southern Engineering Division, Jackson, Mich.



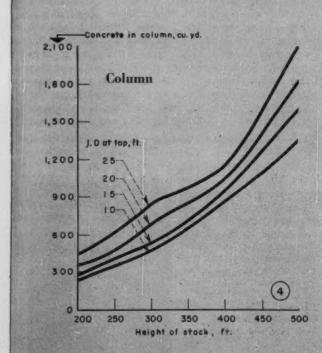
<sup>\*</sup> Based on 600 F. inside temperature and 200 psi. maximum compressive stress.

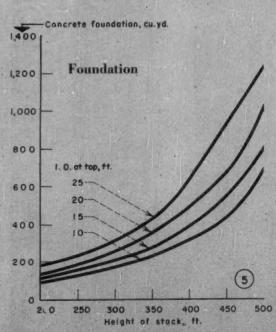
# **BRICK STACKS**—Quantities of Materials

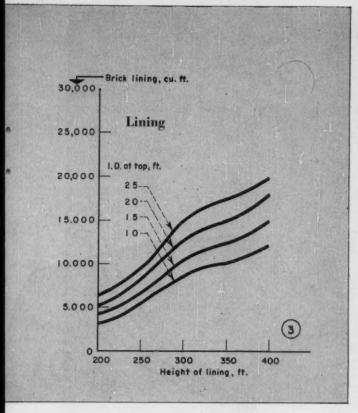


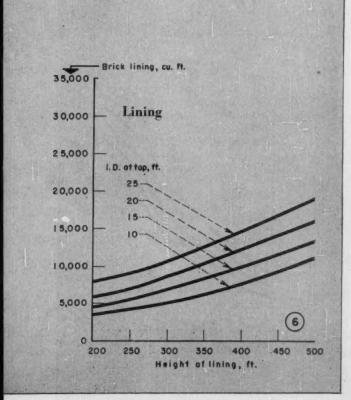


# **CONCRETE STACKS**—Quantities of Materials









and cast iron cap covering stack column and lining.

Fig. 2 gives the cubic yards of concrete required for brick stack foundations. The unit cost per cubic yard, including excavation, formwork and reinforcing steel, ranges from \$35 to \$45.

Fig. 3 gives the volume of radial brickwork for the stack linings. The unit cost per cubic foot including portland cement-lime mortar, ranges from \$2.25 to \$3.70.

### Concrete Stacks

Material quantities for estimating costs of concrete stacks can be obtained from Figs. 4-6.

Fig. 4 gives the volume of concrete for stack columns. The unit cost per cubic yard ranges from \$75 to \$135 and includes reinforcing steel, ladder and cleanout door. It does not include lightning protection system and cast iron cap for stack column and lining.

Fig. 5 gives the cubic yards of concrete required for concrete stack foundations. The unit cost per cubic yard, including excavation, formwork and reinforcing steel, ranges from \$35 to \$45.

Fig. 6 gives the volume of hard burned shale brickwork for the concrete stack linings. The unit cost per cubic foot ranges from \$3.50 to \$4.25 and includes portland cement mortar and the cost of providing 2-in. of insulation or a 2-in. dead air space.

### Steel Stacks

From Figs. 7, 8, 9, and 10 the material quantities for estimating costs of steel stacks can be obtained.

The weights of steel stack sections given in Fig. 7 are based on nominal plate weights plus 15% for extras: tee bars or shelf angles, welds, coping, ladder, base connection and anchor bolts, allowable overweight for plates, material lost in fabrication, and paint. The stack plates were designed to support a 5-in. thick brick lining. No additional plate thickness was allowed for corrosion.

The unit cost per ton of stack section ranges from \$450-600.

Fig. 8 gives the cubic yards of concrete for steel stack foundations. The unit cost per cubic yard, including excavation, formwork and reinforcing steel, ranges from \$35 to \$45.

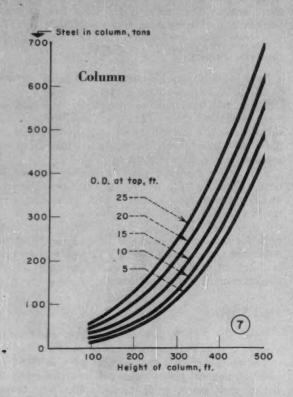
Fig. 9 gives the surface area of linings attached to the steel stack plates. When the breeching connection is located a considerable distance from the base of the stack, a false bottom, protected with a lining and located immediately below the breeching opening, is recommended in place of lining the "dead" space at the bottom of the stack.

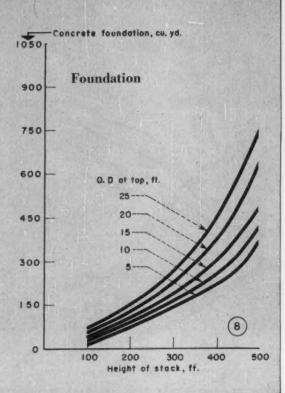
The unit cost per square foot of a 5-in, thick lining—consisting of a 4-in, thickness of vitrified paving brick and 1-in, thick lumnite-silica sand mortar backing—ranges from \$2.25 to \$2.75. The unit cost per square foot for a 2½-in, thick lumnite-silica sand gunite lining, including reinforcing, ranges from \$1.60 to \$1.90.

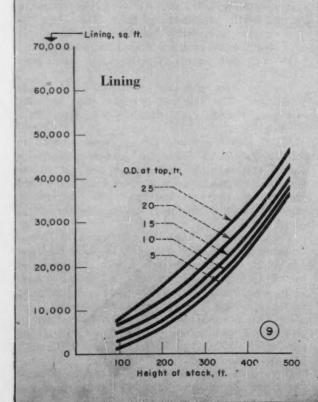
Fig. 10 is for use in obtaining average estimated weights of structural steel required to support a steel stack on the roof of a 100-ft. high building or on a 100-ft. high independent steel tower.

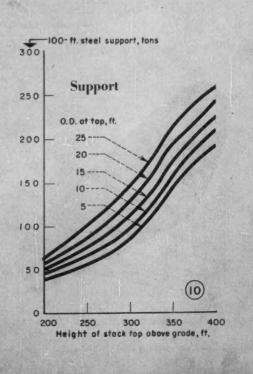
For a 150-ft. high building or 150-ft. high independent steel tower, the estimated weight of structural steel sup-

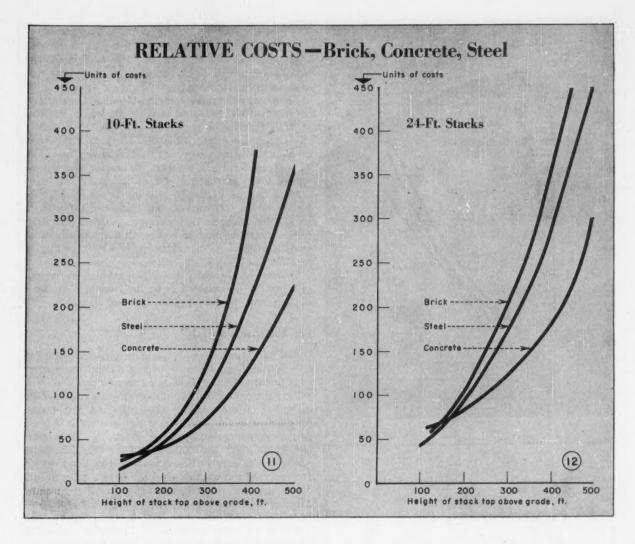
# STEEL STACKS—Quantities of Materials











port happens to be equal to the stack section weight that would have been necessary to increase the height of the stack by 150 ft. For example, the weight of a 150-ft. high structural steel support for a 300-ft. elevation top of stack above grade (a stack height of 150-ft.) is obtained from Fig. 7 by taking the difference in weight between a 300-ft. and a 150-ft. high stack section—the weight needed to reach a total elevation of 300-ft. were it not for the 150-ft. high support.\*

The unit cost per ton of structural steel ranges from \$260 to \$300.

### **How Initial Stack Costs Compare**

Figs. 11 and 12 give an average total initial cost comparison for 10-ft. I.D. and 24-ft. I.D. steel, radial brick and concrete stacks. The stacks are supported at grade elevation on concrete foundations designed for 6,000 lb. per sq. ft. soil pressure.

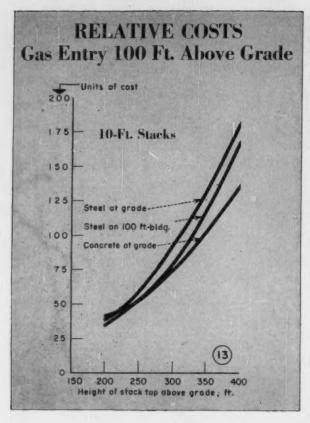
It's important to note that, as stack height increases as it is in many areas due to increasing attention to air pollution control—the cost curves for steel and brick stacks rise more sharply than for concrete stacks. At 500 ft. and higher the savings in initial costs possible through use of concrete stacks is considerable.

All stacks have brick linings for their full height. Steel stack linings are vitrified paving brick laid in lumnitesilica sand mortar; brick stack linings are radial brick laid in portland cement-lime mortar. Concrete stack linings are hard burned shale brick laid in portland cement mortar and have 2 in, of fiberglass insulation or a 2-in, dead air space between the lining and the column.

Lumnite gunite linings for steel stacks cost about one third less than vitrified paving brick linings and this reduction in the cost of steel stacks will raise the intersection of steel and concrete stack cost curves.

Brick stack costs are based on the usual specification of 600 F. inside temperature and a maximum allowable compressive stress of 200 psi. Reducing the inside temperature requirements to 400 F. and increasing allowable compressive stress to 250 psi. reduces the cost of brick stacks and raises the intersection of brick and concrete cost curves to a greater stack height. Savings from the less conservative design conditions will, however, be offset by higher maintenance charges.

<sup>\*</sup>Putting it another way, the structural steel is equivalent in weight—in this particular case only—to a steel stack section of the same height. The over-all cost is less since structural steel is cheaper than stack section steel.



### To Figure Costs . . .

### . . . For Brick Stacks

Column: \$1.90-3.50 per cu. ft. Foundation, concrete: \$35-45 per cu. yd. Lining, brick: \$2.25-3.70 per cu. ft.

### . . . For Concrete Stacks

Column: \$75-135 per cu. yd. Foundation, concrete: \$35-45 per cu. yd. Lining, brick: \$3.50-4.25 per cu. ft.

### . . . For Steel Stacks

Column: \$450-600 per ton
Foundation, concrete: \$35-45 per cu. yd.
Lining, 2½-in. lumnite: \$1.60-1.90 per sq. ft.
Lining, 5-in. brick: \$2.25-2.75 per sq. ft.
Support, steel: \$260-300 per ton

### It May Be Cheaper to Elevate Stacks

In cases where effluent gases enter a stack at elevated levels—near the roof of a building, for example—it may be less expensive to perch the stack on supports at that level rather than build it from the ground up.

Fig. 13 gives an average total initial unit cost comparison between a 10-ft. I.D. steel stack supported on the roof of a 100-ft. building and 10-ft. I.D. steel and concrete stacks supported at grade elevation. The costs of the stacks supported at grade elevation have been taken from Fig. 11 and corrected for omission of the lower—and now unnecessary—100-ft. height of brick linings.

Since the cost of the brick linings represents a higher percent of the total cost of steel stacks than of concrete stacks, the reduction in lining surface moves the intersection point for steel and concrete stacks supported at grade elevation from a stack height of 175 ft. in Fig. 11 to 250 ft. in Fig. 13.

Foundation costs for a steel stack supported on the roof of a building are assumed to be the same as those for a steel stack of the same height supported at grade.

### For Comparison Only

Material quantities and cost data presented here are only intended for use in obtaining relative comparative costs of the various types of stack construction.

For, the initial cost of stacks will vary considerably depending on material and labor costs and freight rates for different localities, as well as the variation in a given area due to current price changes. Then, too, these initial cost figures require an adjustment to allow for the relative advantages of each particular type of stack construction. For example, a steel stack supported over a boiler should be credited with any reduction in the initial and maintenance costs of the flue gas work.

Maintenance costs, downtime for maintenance, and flexibility for future alterations and extensions should be evaluated and credits allotted each type of construction.

Maintenance charges will vary with local climatic conditions, stack gas temperature, type of fuel, frequency of boiler outages or periods of partial loads, materials of construction, workmanship, etc., and should be analyzed for each installation. For example, an eastern utility company has found that the capitalized value of annual maintenance averaged over a 30-year period has in one instance run about 3% of the total cost of stack and foundation for a steel stack, from 5-16% for a concrete stack and about 8% for a brick stack (Van Hohenleiten, H. L. and Kent, R.H., Combustion, Jan. 1953, pp. 53-57).

### ACKNOWLEDGEMENTS

The material quantities and cost data for brick and concrete stacks were prepared by the Custodis Construction Co., Inc. Grateful acknowledgement is made to Messrs. L. Borsody, H. B. Schneider, F. P. Stray and J. Janush of their Chicago office.

The assistance of Messrs. A. N. Konstant, W. Millard and A. C. Rasmussen of Sargent & Lundy in the preparation of this paper is greatly appreciated.

This article is based in part on a paper presented by Mr. Stankiewicz at the annual meeting in 1954 of The American Society of Mechanical Engineers.

**PROBLEM** A heat exchanger for chilling water is to be designed using  $\frac{3}{4}$  in., 18-gage copper tubes. Water is to enter the tube side at 250 gpm. and 70 F., and is to be cooled to 50 F. Exchanger is to have a single tube pass. Heat is removed on the shell side with boiling Freon 12 at 47 F. Water velocity of  $1\frac{1}{2}$  fps. in the tubes is adequate. Under the circumstances this velocity gives an average value of 980 for  $h_i$ , the inside film coefficient. Boiling coefficient for Freon 12:  $h_o = a\Delta T_o^b$ . Values for a and b are taken from table on page 246.

### NUMERICAL SOLUTION

$$\begin{split} W &= (25)(62.4)(60)/7.48 = 12,500 \text{ lb./hr.} \\ c_p &= 1.0 \text{ Btu./(lb.) }_b \text{°F.}); \quad a = 21.2, \quad b = 1.545 \\ K &= A_s/A_b h_t + x A_s/k_b A_m \\ &= 0.750/(0.652)(980) + (0.049)(0.750)/(12)(220.6)(0.701) \\ &= 0.00011978 \end{split}$$
 From Eq. (10):  $\Delta T_{s1} = 2.7 \qquad \text{when } T_{L1} = 50 \text{ F.} \\ \Delta T_{s2} = 11.1 \qquad \text{when } T_{L2} = 70 \text{ F.} \end{split}$  From Eq. (14):  $A_o = 12,500[-0.00074 + 0.0066 + 0.00432] = 127 \text{ sq. ft.} \\ L &= (127)(12)/(\pi)(0.75) = 648 \text{ ft. of tubing} \\ A_t &= 25/(60)(7.48)(1.5) = 0.0372 \text{ sq. ft.} \\ n &= (0.0372)(4)(144)/(\pi)(0.652)^2 = 16 \text{ tubes} \end{split}$  Tube length  $= (648)(12)/(\pi)(0.75)(16) = 21 \text{ ft.}$ 

A = 127 sq. ft. L = 648 ft.

### GRAPHICAL SOLUTION

From Eq. (4):  $U_o = 1/(1/k_o + 0.0011978)$   $dq = U_o dA_o \Delta T = Wc_p dT_L$  $= \frac{1}{Wc_p} \int_0^A dA = \frac{A_o}{Wc_p}$ dTI  $U_{\circ} \Delta T$ Set up graph of 1/U. AT vs. TL 400 AT  $T_L$  $U_{-}$  $U_{\circ \Delta}T$ 3.000 3.38 4.865 6.40 10.120 88.5 102 148.2 192.5 275.0 361.5 50.38 51.87 53.40 57.21 61.66 67.60 73.82 81.2 34.7 18.9 11.9 300 From graph, using Simpson's Rule, Area = 0.00984 10-5  $A_o = 0.00984(25)(62.4)(60)/7.48 = 124 \text{ sq. ft.}$ U. AT  $L = 124(12)/\pi(.75) = 633$  ft. 200 A = 124 sq. ft. L = 633 ft. 100

To avoid errors inherent in the graphical method of designing exchangers with boiling or condensing fluid on the shell side, and to save time . . .

# Reconsider the Numerical Solution

### JOSEPH F. GROSS

Design of a shell and tube exchanger, in which a fluid is boiling or condensing on the shell side, is complicated by the variation of the overall coefficient of heat transfer throughout the exchanger.

Both boiling and condensing film coefficients are functions of the temperature drop over their respective films. Temperature in the bulk of

JOSEPH F. GROSS holds a Du Pont Fellowship at Purdue University. His work is concerned chiefly with mathematical and experimental investigations into the relationships of fundamental heat transfer processes. either the boiling liquid or condensing vapor is fixed by the pressure and, therefore, is constant throughout. However, the film temperature drop is a variable because it is a direct function of the temperature of the metal surface. This temperature varies throughout the exchanger along with the increasing or decreasing temperature of the fluid inside the tubes.

Conventional method of determining the exchanger area is by a graphical integration using Eq. (12) on p. 246.

However, Eq. (14) is a mathematically-correct solution of Eq. (12) and avoids the errors inherent in the graphical method. Furthermore, nu-

merical solution of the integral is less time-consuming than the graphical solution.

The example serves as a comparison of the mathematical and graphical solutions.

### **Development of Design Formulas**

The theoretical relationship most frequently used in determining the condensing coefficient of heat transfer is the Nusselt equation. This equation appears in two forms: one pertaining to condensation on horizontal tubes and other to condensation on vertical tubes. In both forms, the film coefficient of heat transfer is a function

### Equations

$$(1) h = a(\Delta T)^{-0.95}$$

$$(2) h = a(\Delta T)^{b}$$

(3) 
$$dq = U dA \Delta T$$

(4) 
$$U_o = 1/\left(\frac{1}{h_o} + \frac{xA_o}{k_m A_m} + \frac{A_o}{h_i A_i}\right)$$

(5) 
$$U_o = 1 / \left( K + \frac{1}{a(\Delta T_o)^b} \right)$$
(6) 
$$dq = h_o dA \Delta T_o$$

(6) 
$$dq = h_o dA \Delta T_o$$

(7) 
$$h_o \Delta T_o = \Delta T / \left( K + \frac{1}{a(\Delta T_o)^b} \right)$$

(8) 
$$\Delta T = \Delta T_o (1 + K_o \Delta T_o b)$$

$$(9) \qquad \Delta T = T_L - T_s$$

$$(10) T_L = \Delta T_o + K_a \Delta T_o^{b+1} + T_a$$

(11) 
$$dT_L = d(\Delta T_o)[1 + (b+1)K_o \Delta T_o^b]$$

(12) 
$$A_{\circ} = Wc_{p} \int_{T_{1}}^{T_{2}} dT_{1}/U_{\circ} \Delta T$$

(13) 
$$A_o = Wc_p \int_{\Delta T_{o1}}^{\Delta T_{o2}} \frac{1 + aK(b+1) \Delta T_o^b}{a \Delta T_o^{b+1}} d(\Delta T_o)$$

(14) 
$$A_{o} = Wc_{p} \left[ K(b+1) \ln \frac{\Delta T_{o2}}{\Delta T_{o1}} - \frac{1}{ba} \left( (\Delta T_{o1})^{-b} - (\Delta T_{o1})^{-b} \right) \right]$$

of the temperature drop over the condensing film as shown in Eq. (1).

Study of boiling phenomena has led to a simple equation for boiling heat transfer coefficient, Eq. (2). Exponent b is known with somewhat less accuracy than the exponent of  $-\frac{1}{4}$  in Eq. (1). In general, it varies between 1.0 and 3.5.

Myers<sup>2</sup> has reported values for the constants a and b for Freon 12, methyl chloride, sulfur dioxide, n-butane, and propane boiling on plain and finned tubes. These values are shown in the table.

### Constants Used in Formulas

	- Pia	in Tub	es —	- Fin	ned Tu	bes —
Refrigerant	Temp.	4	b	Temp.		b
Freon-12	47 F	21.2	1.545	55 F	110	1.06
Methyl chloride	48 F.	8.45	1.88	48 F.	148.5	0.75
Sulfur dioxide	56 F.	11.8	1.61	55 F.	190.5	0.574
n-Butane	70 F.	57.4	1.17	57 F.	72.5	1.40
Propane	38 F.	86	1.325	40 F.	253	0.854

For the case of water boiling from horizontal plates, Jakob<sup>a</sup> reports a value of 0.985 for a and a value of 3.0 for b. Considerable data are available in the literature which can be readily converted into the appropriate form for determining the required constants.

Basic equation for heat transfer is shown in Eq. (3). Over-all coefficient U can be either U, or U, depending on whether the inside or outside diameter of the tube is chosen as a reference. U, will be chosen here for convenience and can be defined as in

Inside heat transfer coefficient will depend on the character of the inside fluid, the amount of heating or cooling to which it is subjected, and its velocity. Perry\* gives the following equations for the heat transfer coefficient of a liquid flowing inside a tube:

$$hD_i/k = 0.023(Re)^{0.8}(Pr)^{0.4}$$
  
 $hD_i/k = 0.027(Re)^{0.8}(Pr)^{1/3}(\mu/\mu_e)^{0.14}$ 

In most industrial applications this coefficient can be considered constant throughout the length of the exchanger.

The term  $xA_o/k_mA_m$ , representing the resistance of the tube wall, can be calculated immediately and is independent of the heat transfer fluids.

Using the reduced equation for condensing, Eq. (1), or boiling, Eq. (2), the equation for the overall coefficient

### NOMENCLATURE

he = Outside heat transfer coefficient, Btu./(hr.) (sq. ft.) (°F.)

hi = Inside heat transfer coefficient, Btu./(hr.) (sq. ft.) (°F.)

x = Thickness of tube wall, ft.

Am = Mean longitudinal area of tube, sq. ft.

 $A_i =$  Inside area of tube, sq. ft.

 $A_o =$ Outside area of tube, sq. ft.

K = Constant representing resistance of inside film and metal wall.

 $\Delta T_o =$  Temperature drop over the outside film.

 $T_L$  = Temperature of liquid inside tube at any point.

 $T_* = \text{Boiling or condensing temperature}$ of the shell side fluid at same position in the exchanger.

W = Rate of fluid flow inside tube, lb. per hr.

c, = Heat capacity of fluid inside tube, Btu./(lb.) (°F.)

of heat transfer may be expressed as in

An equation similar to Eq. (3) may be written to define the amount of heat flowing through a differential area in terms of the outside coefficient of heat transfer rather than the over-all coefficient. This is Eq. (6).

Combining Eqs. (3), (5) and (6) gives Eq. (7).

By rearranging Eq. (7) we get Eq. (8).

Temperature on the shell side will be constant, so Eq. (9) holds.

Eq. (10) may now be written.

Differentiating Eq. (10), we get Eq. (11).

A differential heat balance over the exchanger gives:

$$dq = wc_p dT_L = dA_o U_o \Delta T_o$$

Thus the required area is as shown in Eq. (12).

Since  $U_o$  and  $T_L$  are functions of  $\Delta T_{\circ}$ , the variable of integration is changed to  $\Delta T_o$  and Eq. (12) becomes Eq. (13).

This can be integrated to Eq. (14).

### ACKNOWLEDGEMENT

Appreciation is expressed to Dr. J. E. Myers for many helpful suggestions in the preparation of this article.

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# More Help in Finding Cost Data



BIBLIOGRAPHY, listing 186 recent references, is annotated to indicate contents of articles.

SUBJECT INDEX helps you locate the references dealing with the specific problem or estimate.

James B. Weaver, Atlas Powder Co., Wilmington, brings up to date his survey of the cost estimation-engineering economics literature. Supplementing the survey published in CE in Oct. 1954, this abridged version covers articles appearing in 1954, along with references omitted from the earlier bibliography.

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# **Chemical Engineering Fundamentals**

#### Interpretation of Kinetic Data—III

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Primary purpose of our two previous installments on the interpretation of kinetic data (Chem. Eng., Apr. 1955, p. 199; and May 1955, p. 203) was to show you how to interpret experimental data on catalytic reactions in order to select the correct mechanism equation and then how to calculate the constants in the rate equation you select.

With the fundamental rate equation the chemical engineer can calculate the amount of catalyst and product distribution for practically any combination of operating conditions that he wants to test. With this equation he can study the effect of varying the ratio of reactants, of recycling of products, of heating, of cooling or of adiabatic operation. By calculation he may study the effect of each operating variable separately and in this way learn the best possible operating conditions.

If the proposed conditions under investigation in a given calculation are such that diffusion gradients are negligible, the rate equation may be used with the partial pressure terms evaluated at the bulk gas stream conditions. If diffusional effects are significant and if appreciable partial pressure and temperature gradients exist over the film surrounding each catalyst pellet, the actual values at the interface must be calculated.

It is recommended that conditions where diffusion has an effect should not be used in experimental work. The method of using the rate equations in the design of a reactor where there is a diffusion effect will be covered in our proposed series on reactor design.

We will see that the methods of applying the equations would hold equally well for equations that are

entirely empirical provided that these empirical equations are valid at the design conditions.

Now for a few words about the application of the mechanism rate equations to fluidized beds.

#### Fluidized Beds

The fluidized-bed reactor is one in which the catalyst is a finely divided powder held in suspension in an upward flowing gas stream. Most commercial reactors have the catalyst in a single bed which has a fairly small length-to-diameter ratio. In this type of reactor there is considerable backmixing of both the gas stream and the catalyst. The gas stream tends to maintain an average uniform composition throughout the bed.

With the violent catalyst agitation inherent in a fluidized bed, the catalyst surface maintains a steady-state uniform condition throughout the bed. Concentration values do not vary throughout the bed as they would in a fixed catalyst bed.

Another type of fluidized bed is a reactor which consists of a number of parallel tubes each of which contains a fluidized catalyst. The ratio of length to diameter for any single tube is high. This reactor is known as a "longitudinal fluidized-bed reactor." It is not yet in wide commercial use because:

- Design for stable operation is difficult.
- There is a lack of general understanding and fundamental information of the advantages of longitudinal reactors.

The degree of agitation of the catalyst in the longitudinal fluidized-bed reactor lies between that of fixed bed and ordinary fluidized bed. Fundamental information on the exact behavior is not known.

In the fluidized-bed reactor the concentrations of the reactants and products both in the gas phase and on the catalyst surface are uniform throughout the bed. If this type of reactor is operated as a differential reactor, it gives the same kind of data as a differential fixed-bed reactor. The data can be treated in exactly the same manner.

If an experimental fluidized-bed reactor with complete backmixing is operated as an integral reactor, the data obtained will not fit the mechanism equations that we have discussed up to now.

#### Nomenclature (Consistent units)

- A. B Reactants
- c Concentration
- F Feed rate
- k Rate constant, forward reaction
- k' Rate constant, reverse reaction
- K<sub>p</sub> Equilibrium constant based on partial pressures
- I An active center
- pA Equilibrium partial pressure of adsorbent gas
- r Reaction rate
- r. Initial reaction rate
- R, S Products
- W Mass of catalyst
- x Degree of conversion

The equations will not hold for a longitudinal fluidized-bed when the catalyst is in violent agitation.

#### Rate Equation for Fluidized Bed

Let's assume that the reaction of A going reversibly to R and S takes place by the following steps on a fixed-bed catalyst:

$$A + l \rightleftharpoons Al \tag{1}$$

$$Al \rightleftharpoons Rl + S$$
 (2)

$$Rl \rightleftharpoons R + l$$
 (3)

Assume that step (2) is the controlling step.

Now let's consider that the same steps hold for a fluidized-bed. The rate equation would be:

$$r = k_2 c_A - k_2' c_R$$

But since the catalyst bed is in constant circulation,  $c_A$  and  $c_B$  do not vary. The rate is constant throughout the bed. Therefore, if the fluidized bed is circulating at infinite rate the mechanism equations don't hold.

However, if the catalyst circulation rate is slow compared to the rate of adsorption and desorption (so that the concentration of adsorbed materials remains in equilibrium with the gas phase) the longitudinal fluidized bed would behave like a fixed bed.

There is room for fundamental research to determine the effect of circulation in specific fluidized catalyst beds. Since the science of kinetics in this area is not yet developed we will not consider the quantitative aspects any further.

#### Kinetic Problems

In the rest of this installment and next month's we'll demonstrate the solution of some problems in the interpretation of experimental kinetic data.

Assume that the data in the table on p. 255 are compiled from a kinetic study made in a fixed-bed type prepilot plant reactor. The reaction type is

$$A + B \rightleftharpoons R + S$$

Let's assume that the value of the equilibrium constant for this reaction at 1,000 F. has been calculated. It was found to be equal to 10.0. That is

$$K_p = p_R p_S / p_A p_B = 10.0$$

We further assume that all data are at 1,000 F.

#### Problem 1-Effect of Diffusion

Problem—From the data given in the table at the right, determine whether or not film diffusion is the controlling factor.

Solution—If the diffusion of any of the reactants or products through the film were controlling a plot of x vs. W/F at different linear velocities would give two different curves for each series of runs using two different catalyst weights (see Chem. Eng., Apr. 1955, p. 200, Figs. 2a and 2b).

If film diffusion were not controlling the relationship between x and W/F for each series of runs would not depend upon the amount of catalyst or velocity.

The procedure to use in this problem is to pick out, if possible, cases from the table of data where the linear velocity (feed rate) and amount of catalyst are both varied independently.

The effect of diffusion will have to be tested for separately at each set of pressure and feed composition conditions. That would be six tests in all.

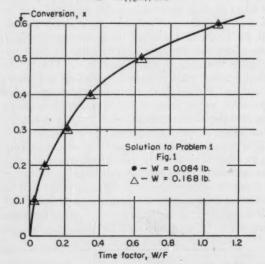
We'll work out one test here and leave the other five to you. Testing for diffusion at 1 atm. and with 50% A in the feed, we can calculate these values:

Run	%R	W/F	x
1	30	1.074	0.60
2	15	0.203	0.30
3	25	0.640	0.50
4	10	0.093	0.20
5	20	0.374	0.40
6	5	0.0325	0.10
7	5	0.0325	0.10
8	15	0.203	0.30
9	25	0.634	0.50
10	10	0.093	0.20
11	30	1.074	0.60
12	20	0.374	0.40
13	15	0.207	0.30

Sample calculation: W/F = 0.084/0.0781 = 1.074

Sample calculation of 
$$x$$
:
$$\begin{array}{ccc}
A + B \rightleftharpoons R + S \\
(1 - x)(1 - x) & (x)
\end{array}$$

$$\%A = 0.5 (1 - x) 100$$
  $\%R = 0.5x (100)$   
 $x = 2(\%R)/100$ 



The calculated values given in the table above are plotted in Fig. 1. We can see that the curves coincide. Therefore for the case of 1 atm. pressure and a 1-to-1 mole ratio, diffusion is not controlling.

#### Problem 2—Determine Initial Rates

Problem—Determine the initial rates of the reaction for each of the six series of runs shown in the table.

Solution—For the purpose of simplification we will solve this problem only for one of the series of runs presented. However, we will demonstrate three graph-

#### Data for a Kinetic Study at 1,000 F.

Run	Feed Rate LbMole/Hr.	Catalyst Mass Lb.	
			% R
		Feed composition, 50°	
1 2	0.0781 0.414	0.084	30 15
3	0.1327	0.084	25
4 .	0.904	0.084	10
5	0.225	0.084	20
6	2.584	0.084	5
7	5.17	0.168	5
. 8	0.828	0.168	15
9	0.266	0.168	25 10
11	1.810 0.517	0,168 0,168	30
12	0.614	0.168	20
13	0.812	0.168	15
Series 2	2—Pressure, 4 atm.;	Feed composition, 509	% A
14	0.253	0.084	20
15	2.545	0.084	5
16	0.445	0.084	15
17	0.0959	0.084	30
18 19	0.904 0.1545	0.084 0.084	10 25
20	0.1995	0.168	20
21	0.506	0.168	20
22	0.890	0.168	15
23	0.506	0.168	20
24	5.09	0.168	5
25	1.922	0.168	30
26° 27	0.3095 0.1807	0.168 0.168	25 10
Series 3		; Feed composition, 50	
28	0.4575	0.084	15
29	2.625	0.084	5
30	0.0952	0.084	30
31 32	0.264 1.847	0.084 0.168	20 10
33	0.3155	0.168	25
34	0.527	0.168	20
35	5.25	0.168	5
36	0.915	0.168	15
37	0.190	0.168	30
Series 4	Pressure, 1 atm.;	Feed composition, 20%	% A
38	0.875	0.084	6
39	0.1413	0.084	16
40	0.391	0.084	10
41	3.50	0.084	2
42	0.199	0.084	14
43	0.276	0.084	12
44	1.528	0.084	4
45	1.128	0.168	8
16 47	0.774	0.168 0.168	4
48	3.055 7.00	0.168	2
49	1.75	0.168	6
50	0.398	0.168	14
Series 5	-Pressure, 4 atm.;	Feed composition, 20%	A
51	0.236	0.084	14
52	0.958	0.084	6
53	3.63	0.084	2
54	0.325	0.084	12
55	1.61	0.084	4
56	0.461	0.084	10
57	1.287	0.168	8 2
58 59	7.27 0.650	0.168 0.168	12
Series 6	Pressure 10 atm	Feed composition, 20	07_ A
60	Pressure, 10 atm.;		% A 10
61	0.526	0.168 0.168	16
62	7.30	0.168	2
63	1.97	0.168	6
64	3.28	0.168	4
65	1.331	0.168	8
66	0.710	0.168	14
67	0.732	0.168	12
68	0.483	0.084	10
69	0.985	0.084	6 2
70 71	3.65 1.468	0.084 0.084	4
72	2.63	0.084	16
-			. 4

ical methods on the same series of runs so that the methods can be compared. Solutions for the other series of runs will be left to the reader.

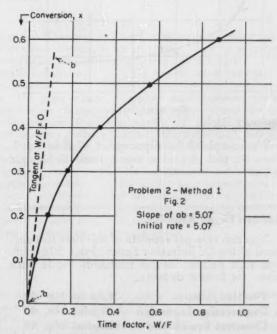
The three graphical methods are:

- 1. Measure the slope of the tangent at the point x = 0, W/F = 0.
- 2. Measure the slope of the tangent at several points along the x vs. W/F curve and plot the slopes vs. W/F. Then extrapolate this plot to W/F = 0.
- 3. Plot x/(W/F) vs. W/F and extrapolate the curve back to W/F = 0.

#### Problem 2-Method 1

The table below shows the result of applying Method 1 to runs 14 through 27. During these runs the pressure was 4 atm. and there was a 1-to-1 mole ratio in the feed. Fig. 2 is then plotted from the calculated values in this table.

Run	%R	W/F	x
14	20	0.332	0.40
15	5	0.033	0.10
16	15	0.189	0.30
17	30	0.875	0.60
18	10	0.093	0.20
19	25	0.544	0.50
20	20	0.842	0.40
21	20	0.332	0.40
22	15	0.189	0.30
23	20	0.332	0.40
24	5	0.033	0.10
25	30	0.875	0.60
26	25	0.544	0.50
27	10	0.093	0.20

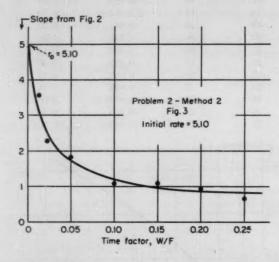


The slope of the line ab in Fig. 2 can be measured. We find that it is equal to 0.355/0.070 = 5.07. Therefore,  $r_0 = 5.07$ 

#### Problem 2-Method 2

Method 2 requires that we measure the slopes of tangents at various values of W/F and plot these slopes vs. W/F. Then we extrapolate the curve obtained this way back to zero. We now use Fig. 2 to give us the values in the table below.

W/F	$x_2$	$x_1$		$(W/F)_2$	$(W/F)_1$
0.010	0.575	0.130		0.160	0.035
0.025	0.560	0.200		0.230	0.075
0.05	0.595	0.230		0.300	0.100
0.10	0.580	0.285		0.420	0.165
0.15	0.595	0.315		0.505	0.260
0.20	0.615	0.320	1	0.575	0.275
0.25	0.635	0.415		0.670	0.350
$x_2 - x_1$	$(W/F)_2$	$-(W/F)_1$		Slope	W/F
0.445	0.1	25		3.56	0.010
0.360	0.1	55		2.32	0.025
0.365	0.2	00		1.77	0.05
0.295	0.2	55		1.16	0.10
0.280	0.2	45		1.14	0.15
0.295	0.3	00		0.982	0.20
0.220	0.3	20		0.687	0.25



We have ploted the slopes against W/F in Fig. 3. From the plot, the initial rate is found to be equal to 5.10.

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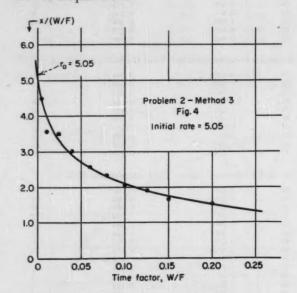
#### Problem 2-Method 3

Now for the last of the three graphical methods that we'll demonstrate here. Plot x/(W/F) vs. W/F and extrapolate the curve back to W/F=0.

The data below are taken from Fig. 2 and are used for the plot shown in Fig. 4.

И	7/F	x	x/(W/F)
0	.005	0.022	4.40
0	.10	0.036	3.60
0	.02	0.07	3.50
0	.04	0.120	3.00
0	.06	0.157	2.61
0	.08	0.186	2.32
0	.10	0.210	2.10
0	.125	0.238	1.90
0	. 150	0.263	1.68
0	. 200	0.308	1.54

The data in the table above are then plotted as shown in Fig. 4. From this plot we determine the initial rate. It is equal to 5.05.



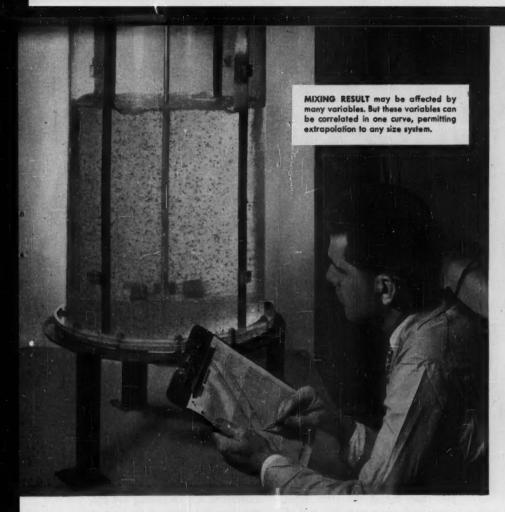
Thus the application of these three graphical methods to this particular series of runs yields essentially the same initial rate for all three methods.

#### NEXT MONTH

We'll present two more completely worked out examples showing how to interpret kinetic data.

#### COMING SOON

Next month's installment will bring to a close our discussion on the Fundamentals of Reaction Kinetics. We are now scheduling a CE Refresher series on the Fundamentals of Reactor Design. Watch for it. You won't want to miss it.





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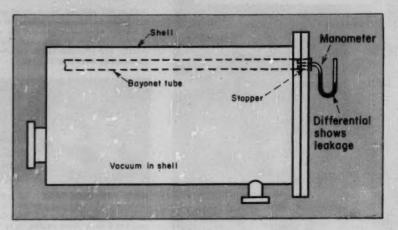
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# The Plant Notebook Edited by Theodore R. Olive



**★Winner of March Contest** 

#### Sure Way to Test Condenser Tubes

Frank G. Radis

Plant Superintendent, Montrose Chemical Co., Newark, N. J.

Recently we had occasion to test the tubes in a special design of bayonet-tube condenser equipped with an impervious graphite shell and tubes. We came up with a method of testing which is quick and sure and, we believe, novel. Furthermore, the same method can with slight modification be used equally well on any type of tubular heat exchange equipment, whether of metal or non-metals, and regardless of whether the equipment is of the bayonet-tube type, or has straight-through tubes, or hairpin or coiled tubes.

Testing the outer tube of a bay-

onet-tube condenser is a little simpler than testing the other types mentioned, since only one end of the tube is open. The sketch above shows how we made the test on our bayonet-tube condenser. First we took down the water end, removing the head, the metal tube sheet and the inner metal tubes. This left the open ends of the outer bayonet tubes exposed.

The condenser is used in a vacuum system so it was easy to pull a vacuum on the shell for the test. To show the presence of leaks we used a small U-tube manometer, filled with water and fitted at one end with a rubber stopper sized to fit the inner diameter of the tubes. It required only half an hour to plug the manometer into each of the 75 tubes individually and complete the test.

When the manometer is plugged into a sound tube it shows a slight positive differential, owing to compression of the air in the tube as the stopper is pushed in. A leaking tube will give a negative differential, and the rate of increase in differential will show how bad the leak may be. Even a slight leak can thus be found and any leaking tubes positively identified. Small leaks, caused for example by porosity, are difficult to find by other means.

To use the method for testing heat exchange equipment other than the bayonet-tube type obviously requires plugging the other end of each tube as it is tested. A convenient way of finding the correct tube is to use an air hose at the test end and identify the opposite end by means of the air blast. Regardless of the type of condenser, this procedure will pin-point any leaking tubes on the first test.

When water is used to test for leaking tubes it is often hard to find small leaks due to weepage of water from scale or sediment in the tubes. Conversely, the scale may absorb water and obscure the leak. Finally, on humid days, there may be enough condensation of moisture in the tubes or on the tube sheet

★Winner of April Contest:

How to Introduce Time Delays Automatically Into Process Controls.

Winner of the April Plant Notebook Contest, this article has earned for Joseph R. Wilson, mechanical engineer with Stratford Engineering Corp., Kansas City, Mo., a prize of \$50 in cash. You can read in the July issue how Mr. Wilson's ingenious but very simple idea can be used on boiler fuel lines and process controls.

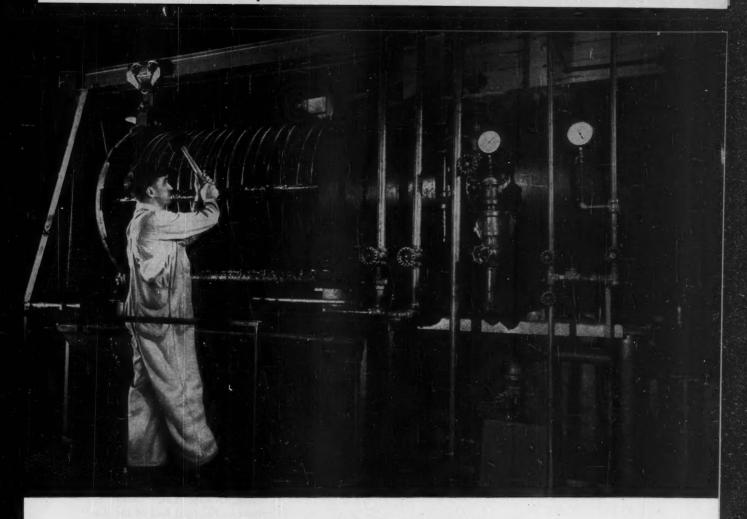
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Each month's winner will be announced in the issue of the second following month, and published the third following month.

\$100 ANNUAL PRIZE—At the end of each year the monthly winners will be rejudged to determine the year's best Plant Notebook article which will then be awarded an additional \$100 prize.

HOW TO ENTER CONTEST—Any reader of Chemical Engineering, other than a McGraw-Hill employee, may submit as many entries for this contest as he wishes. Acceptable material must be previously unpublished and should be short, preferably not over 500 words, but illustrated if possible. Acceptable nonwinning articles will be published at regular space rates (\$10 minimum).

Articles may deal with plant or production "kinks," or novel means of presenting useful data, which will interest chemical engineers. Address Plant Notebook Editor, Chemical Engineering, 330 West 42nd St., New York 36, N. Y.



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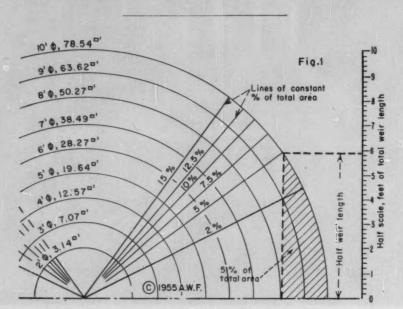
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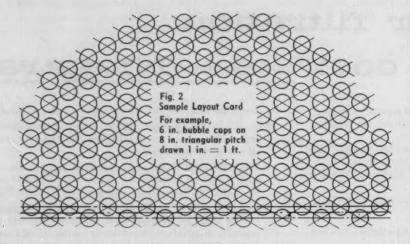
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to make it difficult or impossible to distinguish between seepage and condensation.

Although we used vacuum on the shell in these tests-because it was already available—we could just as well have used air pressure. Had we done so, leaks would have shown up as an increasing positive differential on the manometer, rather than as a negative differential in the vacuum method.





#### **New System Simplifies Tray Layout**

A. W. Francis

Chemical Construction Corp., New York, N. Y.

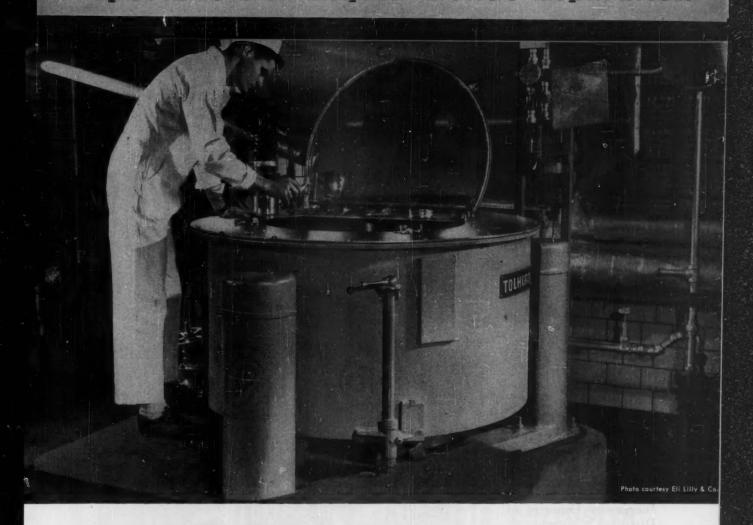
Much of the drudgery in the mechanical layout of bubble-cap trays can be eliminated by the simple system described here. Usually such layout requires a time-consuming trial-and-error process, with several trial tray layouts to achieve a proper balance between liquid downflow and riser area. Each layout must be checked by process calculations for plate stability, hydraulic gradient, and other criteria proposed by various authors. With the system developed by the author, no actual layouts need be made until the final tray has been determined.

The essential idea is illustrated in Fig. 1 which represents a transparent plot of concentric semi-circles (shown here cut off at the left for space saving, but for use drawn as full semi-circles). The drawing shows tray diameters from 2 to 10 ft. For practical use, intervals of ½ ft. for the semi-circles are better. A convenient scale is 1 in. = 1 ft. The device can of course have any range of diameters. Although it can be used if drawn on translucent tracing cloth, it is easier to use if reproduced on transparent film by photography.

The series of radiating lines (actually curves), identified with percentages of total area, mark the points where vertical chords representing weir length cut the various circumferences. Lines similar to those in the right half of the diagram are drawn for the cut-off lefthand portion as well. The indicated percentage means that a vertical chord from the intersection point of a line with a circumference will subtend that percentage of the total circle area to the right of the chord. Chords dropped from the 5% line, for example, will mark off an area of 5% of any of the several circles. But since the downcomer at the opposite side of the plate will subtract an equal amount from the free area of the plate, then the total free area will be  $100 - (5 \times 2) =$ 90%, where free area of the plate is defined as total area, less liquid downflow area.

To determine the length of weir which will be needed for any percentage of downflow area, the scale at the right is drawn to half the scale of the circles. This multiplies the chord height from the centerline to the circumference by two, to provide for the fact that the weir length is extended an equal distance below the centerline. Thus a horizontal line from any percentage intersection point to the scale will mark the actual weir length.

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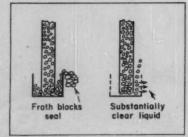
As a further convenience in converting the percentage of total plate area to square feet, each circle is marked with its area.

To construct such a diagram the percent total area lines are best located by a table of values of segmental areas, e.g., Perry's "Chemical Engineers Handbook," 3rd Ed., p. 32, 1950.

For any circle within the scope of the diagram, it is immediately possible to determine the length of any downflow weir, and the corresponding downflow area and free area. If necessary, it is feasible to interpolate between either the circles or the % total-area lines.

As a second feature of the new system, it is a good idea to draw up a number of tray layout cards to the same scale as that used in Fig. 1. These cards can be made for several typical size bubble caps and cap spacings, for example: 3-in. caps on 5-in. 60° triangular pitch;

4-in. caps on 6-in. 60° triangular pitch; and 6-in. caps on 8-in. 60° triangular pitch Fig. 2 is a reduced-size sample of the last-named arrangement. With Fig. 1 and the layout cards the designer now superposes the transparent Fig. 1 over a suitable layout card and immediately has a tray layout which defines the number of bubble caps that can be positioned in any combination of downflow area and free area he may select.



#### Increasing Capacity of Distilling Columns

Om P. Kharbanda

Research Dept., Simon-Carves Ltd. Stockport, England

In some types of beer stills used in the alcohol industry for distilling grain mashes, the liquid downpipes lead into cups which act both as a seal, and as an overflow weir. This arrangement is shown in the sketch at the left above. On account of excessive frothing of ethanol-water solutions at the boiling point, these cups seriously limit the liquid capacity of the column. Space in the cups is insufficient to permit disengagement of the vapor bubbles from the liquid.

An easy way to overcome this disadvantage is to perforate the sides of the cups. Then, as the liquid-vapor mixture impinges against these perforations, the vapor is disengaged and flows upward. The liquid, substantially free of vapor bubbles, flows out through the perforations and on to the plate itself. This action is illustrated in the righthand sketch above.

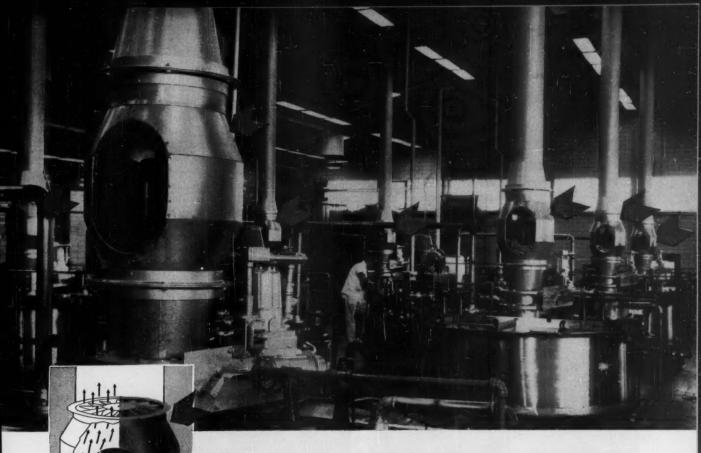


#### Radioactive Gage "Weighs" Bagasse

At its experiment station at Ewa Plantation, the Hawaiian Sugar Planters Assn. has developed a successful experimental model of a radioactive gage for measuring the flow of wet bagasse as it leaves the end of a conveyor belt. Radioactive gages are being used to an increasing extent for measuring the thickness of moving webs of materials, but this is the first time, so far as is known, where the material meas-

ured has been a loose, non-homogeneous material.

Previous Hawaiian experience with other methods of continuously measuring the weight of wet bagasse has been unsatisfactory. Incoming cane is weighed, but it contains large amounts of soil, rock, dirt and weeds. The juices recovered from the pressing operations are weighed accurately, but it is impractical to weigh the soil and trash



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that are washed away. Therefore, up to this time, it has been possible to determine the incoming weight of clean cane only by estimate.

Now, however, two years of tests of the radioactive gage have shown an error of less than 2% in measuring the flow of wet bagasse. This makes it possible for the first time, in conjunction with frequent spot

checks of the bagasse moisture content, to figure back accurately to the weight of clean cane processed.

The bagasse discharges from the end of a conveyor belt for a free fall of a few feet, dropping between a source of radioactive cobalt 60 (cesium 137 has also been used successfully), and a Geiger tube long enough to cover the full width of flow of the bagasse. The falling

material absorbs some of the radiation and the loss, as measured by the Geiger counter, is interpreted as weight of material passing. Although the quantity of material, and the absorption, may vary from time to time across the flow stream, this method averages out the variations. Studies looking toward the use of the method for measuring raw sugar are now under way.



VISCOUS mass drops from tank to pump . . .



IS JETTED to ends of tank car.

#### Gear Pump Conquers Thixotropic Slurry

J. D. Moore

Superintendent, Seawater Magnesia Plant, Kaiser Aluminum & Chemical Co., Moss Landing, Calif.

Since installing a Kinney Heliquad pump for loading magnesium hydroxide into tank cars over a year ago, the Moss Landing, Calif., plant of Kaiser Aluminum & Chemical Co. has cut loading time per 8,000-gal. car from 48 hr. to only 75 min. Unexpected byproducts of the new handling method have been a homogenized product of better consistency, more load per car, and easier unloading of the product from the car at its destination.

Formerly the hydroxide was dropped by gravity from the screw

conveyor which removes it from the filter, direct through a load-out pipe into the waiting tank car. The viscous, high-solids material would build up into a mound under the manhole and would have to be bumped to distribute the load, then filled again. The operation took some 48 hr. Furthermore, there was a tendency toward water separation during transit which made unloading difficult for the user without additional mixing and dilution.

Installation of the Heliquad pump solved the loading problem

neatly, made it possible to recirculate the hydroxide in the loading tank on occasion if the product became excessively viscous, and greatly improved the consistency. The unexpected homogenizing effect is explained by Kinney engineers as the result of the wiping action of the gear faces against the thixotropic material as it passes through the pump.

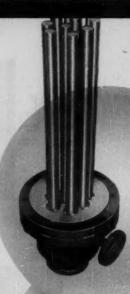
The pump intake from the loading tank is 8 in., and the outlet 8 in., branching to 6 in. recirculation and car-loading lines. Discharge pressure is usually about 60 psi. The car-loading drop pipe is bushed down to a 4-in. tee, which in turn is bushed down to two 4-in. nipples which serve as nozzles to jet the hydroxide stream to the extreme ends of the tank car. This assures filling the ends first and loads the car more fully.



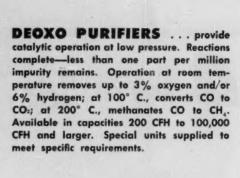


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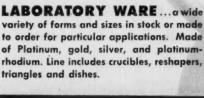
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# You and Your Job Edited by Hugh T. Sharp

New Nationwide Survey Reveals . . .

# **How Industry Trains Its Engineers**

- Programs vary from formal courses to "a handbook and a handshake."
- Job rotation is the major ingredient in most training recipes.
- Critics score some plans for filling company needs, neglecting the man's.

A JUST-COMPLETED study of training programs tells how some 200 companies, big and small, bridge the gap between college and industry for newly-employed engineers.

The study, conducted by the Professional Engineers Conference Board for Industry working with the National Society of Professional Engineers, delved into all phases of engineer training in industry. The Board came up with a set of interesting observations on the value of the training now being done and some recommendations for developing better and better-directed plans.\*

WHAT THE BOARD FOUND

The PECBI survey found that:

• Industry generally has willingly accepted its new role—continuing the young graduate's education in specific engineering techniques.

Industry also has subscribed
 —albeit with less enthusiasm—to
 helping its engineers earn advanced
 degrees and take further studies to
 raise their technical competence.

 Companies, especially the smaller ones, are relying on management development programs to increase the supply of engineerexecutives.

• Training is often directed toward specific jobs, and an analysis

of the types of courses given shows too little interest in the engineer's intellectual, cultural or professional growth. This may satisfy immediate needs of the company, but it neglects the long-range needs of both company and individual engineer.

• Follow-up is the forgotten phase of most programs. After the hubbub of training, the engineer is generally left to his own devices and seemingly forgotten about by management.

TRAINING CATCHES ON

As PECBI points out, the growing complexity of plant and indus-

#### 208 Companies Surveyed

The Professional Engineers Conference Board for Industry in cooperation with the National Society of Professional Engineers questioned more than 500 companies on their engineer training programs. Of 208 replies, 90 came from companies employing more than 100 engineers and 118 from companies with less than 100. Most of the 118 employed less than 25 engineers.

PECBI backed up the questionaires by sending researchers to a number of firms to talk to executives, training supervisors and the engineers themselves. Results and recommendations are presented here.

try operations has widened the gap between school-learned fundamentals and in-plant practice and has turned more and more companies to training to cushion the adjustment from school to work.

It's been estimated that some 5-10 billion man-hr. per yr. are now devoted to training by American industrial concerns. Of the 208 respondents to the survey, over 100 have carefully thought out, definite—though not necessarily formal—plans.

The programs are catching on with engineers, too. Companies which have them report that they aid in attracting men and point to lower turnover rates as proof of the importance of the plan to their engineers.

HOW IT'S DONE

No single training program, reports PECBI, is typical of all, or even of any considerable number of the reporting companies. But the types of training offered fall into a more or less general pattern.

Only a small proportion of the respondents apparently still feel that "nothing can take the place of experience." A growing number hold that the lessons of experience are much more readily learned with a little guidance from the boss.

Over 60% of those surveyed conduct definite training programs for incoming engineers. About half are formal courses, built mainly around rotational job assignments, supple-

<sup>\*</sup> The \$2-page report, Executive Research Survey No. 4, "How to Train Engineers in Industry," is available from the National Society of Professional Engineers, 1121 15th St., N. W., Washington 5, D. C. Price \$2.





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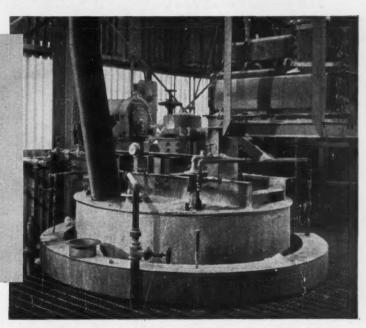
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mented with group discussions and formal studies. The balance are informal plans predicated upon close personnel supervision and guidance from management. Training is entirely on company time in 90% of the firms.

Formal programs, including classroom work, lectures, group discus-

". . . most striking aspect of the training picture is the apparent lack of uniformity in methods or scope of programs."

sions and frequent conferences with key executives, characterize the larger companies, while some of the small firms report that they do little more than place a booklet in the trainee's hand and take him in to "meet the Boss." Most, however, manage in some manner to get a similar body of basic induction information to their new engineering employees.

Quotes sprinkled throughout these pages were distilled from the PECBI report—EDITOR.

START WITH ORIENTATION

Some form of planned orientation and indoctrination of newly-hired engineers was listed by 92% of those who do any training whatever. These plans varied from a week to three years in length and from an atmosphere of extreme informality to an almost academic stiffness.

All seek to acquaint the new man with the company's history, policies, procedures, benefit plans, products, the plant's physical layout and key company people.

Those with a minimum of training facilities rely on "employee's handbooks" and other printed or mimeographed material, plus interviews with key management people to get their story across. In some of the larger companies, these are supplemented with elaborate instructional material, regular classroom courses and supervised plant tours.

Curiously, the handful of companies which devoted no time at all to orientation were large ones—employing over 100 engineers each. AFTER THAT, MORE TRAINING

According to PECBI, the survey not only revealed a growing awareness of the value of orientation training, it also showed an acceptance of the philosophy that this is only part of the job.

After orientation, the engineers go into specialized plans—usually administered by the engineering department. (Industrial relations departments handle this training in about 30% of the reporting plants, while 20% use an interdepart-

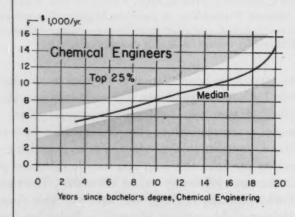
". .'. another research study reports that concerns with a history of poor labor relations tended to have formalized management development programs."

mental committee.)

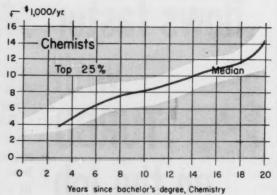
Programs which operate completely outside of the line operation were not treated in the PECBI report, since such a set-up—even if desirable—would be too unwieldly and too expensive for most firms.

Training techniques vary, but job rotation is the most common. A wide range of on-the-job training

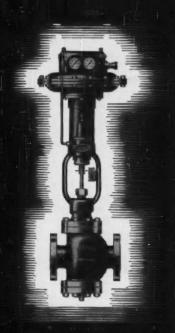
#### Next Month: New York Area Men Talk About Their Salaries



The Chemical Industry Association, New York, an organization of professional chemical industry people, has conducted a salary survey among engineers and executives in the metropolitan area. Above are the over-all results. A greater-than-expected response has



forced us to defer detailed breakdowns until next month. So check July's You & Your Job to see how your pay rate stacks up against those in the New York area. You'll also learn how the men surveyed feel about how well-paid—or poorly-paid—they are.



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assignments is the backbone of about 75% of the programs for young engineers. The average program lasts a year and includes about three or four assignments. More comprehensive plans include from 12 to 20 different jobs, usually widely varied.

#### GETTING A BETTER JOB

Eighty-five percent of the large companies, including some with no orientation plan, have other types of training activities in addition to job rotation, to help employees

"... too many programs are little more than a name to attract engineers, they're very superficial. They advertize highly, but when you ask to see material or outline, there isn't any."

qualify for better jobs. Some involve courses conducted on company property by company personnel; others pay all or part of the employee's tuition for engineering courses in colleges and universities.

Nearly a third of these permit their engineers to take these courses

on company time.

About 36% of the reporting companies grant time off for refresher courses for professional registration. Some 60% of these run such courses themselves, and 66% pay registration fees.

Of the large firms, 44% sponsor formal management training courses. And about half sponsor full-time university fellowships in business administration for selected employees.

#### SMALL PLANTS LESS FORMAL

Training plans of smaller companies, PECBI found, tend to be much more informal than those of larger concerns, and, naturally, considerably smaller in scope. Job rotation, close supervision and individual guidance form the basis of most-with a good deal of emphasis on management training.

All of the small companies which did any training at all said they had orientation and indoctrination programs-and 10 others reported some orientation work, though on an unplanned basis.

Only 14% have formal plans, the

rest depend upon their supervisors for indoctrination. A number also used informal group discussions. But for many, printed booklets were relied on to acquaint the new engineer with the company. Says PECBI, "All too often this consisted of a single leaflet containing only the sketchiest of information.'

In 25% of the small firms employees are encouraged to take advanced studies via company tuition payments, and 14% permit their men to take courses on company time. Full-time fellowships to enable engineers to pursue graduate work are given by only 8%. But 28% support full-time scholarships for undergraduates.

#### TRAINING TRAINERS

The vast majority of the employers surveyed stress that the first line supervisor is the key to their training system. No matter how carefully orientation material, rotational schedules and study courses are prepared, it's the trainee's first boss who can make or break the pro-

There are important exceptions, but 87% of the large plants and even greater proportion of smaller ones, rely on line supervisors for the bulk of the training work. At Dow Chemical's Midland, Mich., plant, for instance, a large and active educational department acts

"... free flow of communications between the trainee and management is characteristic of the better training programs. Trainee-management contacts are self-defeating when the trainee feels he is playing the less desirable role in a cat-andmouse game."

solely as a service group, to help line supervisors do a better training

Dow places great emphasis on finding and developing supervisors capable of leading and dealing with people. The company relieves new supervisors of all job duties for a week during which they take a formal induction course, then regular monthly conferences, in working hours, continue the man's training.

These conferences tend to both broaden his horizons and fire his

#### **How Phillips Trains Recruits**

The training program conducted by the production department of Phillips Petroleum Co. is an example of a wellorganized, formal plan. Phillips bases its training on the widely used job-rotation principle-though from the trainee's angle it's program is much tougher than most.

#### On the Job

The production department's program lasts 52 weeks, during which the trainee handles 18 to 20 working assignments in periods of one to eight weeks each. These vary from oil field helper to district engineer and include both field and office jobs.

Regular biweekly meetings at which topics of prime interest to trainees are discussed and bimonthly conferences with the district superintendent or his assistant are featured. Meetings link field work with engineering and operations, while the bimonthly conferences enable the superintendent to follow the trainee's progress.

In addition, his assignment supervisors rate and report on his progress. And the trainee is informed of these

ratings.

#### On His Own

Training is seasoned with plenty of paper work. At the end of each assignment, the fledgling engineer must submit a written progress report on certain phases of the work-plus any comments or criticisms he cares to make

The trainee also gets a list of required reading to be done on his own time. The list includes 25 reference works, five trade journals, the periodicals of his technical society and a number of specific technical papers on the various phases of oil production.

At the end of his training period, he must turn in a final report including:

· History of the oil industry in the U.S. (a 2,500-word outline). · History of the oil fields to which

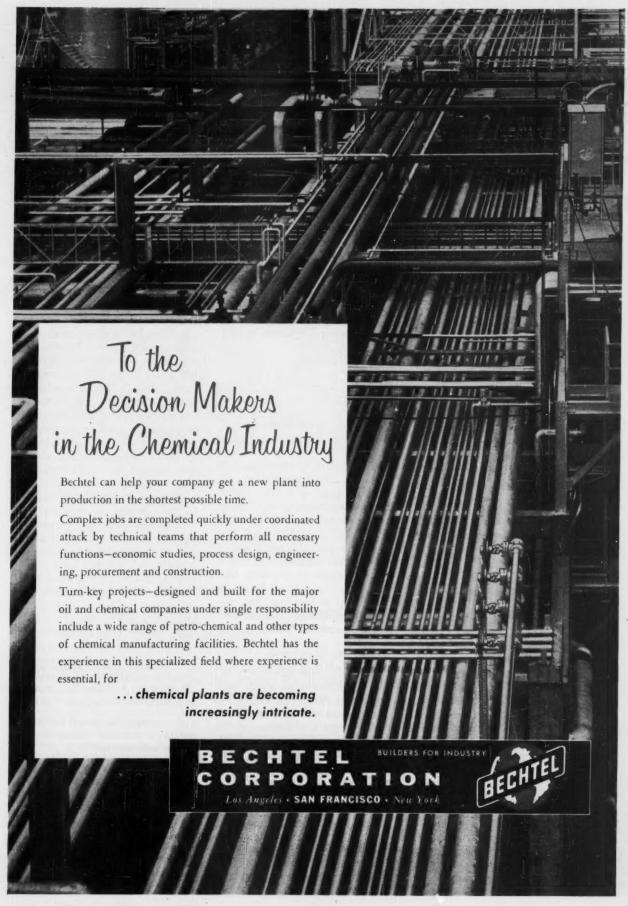
he was assigned.

· Summary of the work he did during training-including a write-up of any special work in which he is particularly interested.

· Abstract by chapters of a specified book on technical writing.

· Answers to all the questions in a 51-page questionnaire designed to reveal in detail how much he's learned about the oil business.

When the report's been reviewed, he's told of the reaction to it and guided in reinforcing his weak points. Then, Phillips feels, he's an engineer.



#### What Makes a Good Training Program

Ask the average training officer how effective his company's program is and the odds are he'll unhesitatingly proclaim its success. Other department heads in that company will usually echo his feelings. But where independent psychological testers, using scientific techniques, have assayed engineer training programs they've often concluded that training had only a very limited effect. Such plans are little more than window-dressing, deceiving both management and engineers.

What makes a program good? Here's what the PECBI survey reports. Check your company's plan—if it has one.

• Orientation — The trainee is given a true and frank presentation of company policy. He gets a chance to get to know the company. Then he's supervised and guided through a planned (though not necessarily formal)

program with the pathways for development charted. He has opportunities for increasing his job knowledge and for all-around development.

- Stimulation Personal contacts with management keep him informed on his progress. Weak points are pointed out and he is advised on strengthening them. Opportunities for advanced study are provided and he is encouraged to use them.
- Challenge Work assignments are widely varied and a good many demand a high order of engineering. The years following the training period feature conferences with his superiors which inform him of his current progress and which give him further challenges to his talents—including registration and active participation in awayfrom-the-job activities.

enthusiasm for the tough job of day-by-day training.

Most companies with supervisory (30%) seemed inordinately high to the Board.

About half of the companies start all trainees at the same salary. Of the 70% which give raises during training, two-thirds give pay raises as earned, the others prefer automatic hikes at stated intervals.

This question of trainees' salaries evoked some interesting comments from a number of employers who feel that starting salaries have been pushed up so high that they preclude "very necessary" incentive increases during the training period.

these upon the employee."
more formal "human relations"
training—though some employers
doubt the effectiveness of such

development programs lean toward

". . . one training authority holds

that the boss cannot ordinarily

serve as an effective counselor, his

problems require certain types of

training. He must necessarily urge

Weighing the conflicting evidence, PECBI concludes that "it would appear that the manner of teaching human relations rather than the subject matter itself, might be at fault in the companies where the research projects (which showed such courses to be ineffective) were carried out." The Board notes that a majority of the firms with the most successful supervisory development programs emphasized this type of training.

#### HOW ABOUT MONEY

A large majority of the companies which participated recognize the importance of financial incentives to trainees, although the number of firms which grant no pay

#### RATING AND EVALUATING

To know who gets the raise, nearly all companies which train have some means of checking the performances of the trainees. About half rely on a composite of the ratings assigned by supervisors; 30% use personal contacts as the rating basis and 10% depend on written examination and reports.

Follow-up on the recent graduate of the program seems to be one of the most neglected areas in the training picture, according to PECBI. This has a marked effect on the rate of turnover among graduates. One firm reports that

70% of its trainces leave the company in 10 yr., 50% shoving off in the first five years.

Companies with strong programs and superior policies with respect

"... valuable advice on program improvements can come from the man who's just been through the mill, and his evaluation of the program's effectiveness is usually highly accurate."

to professional personnel claim that their turnover rate among engineers is almost nil.

#### WHAT IT COSTS

Cost of training ranges from the husky \$5 million per yr. widely cited as the outlay General Electric makes for its far-reaching educational activities to simply an altered point of view for management. It can include a chartered university, a full roster of courses from high school through graduate school, management training conferences and a department of industrial education, as does the Chrysler Corp.'s plan. Or it can consist entirely of a supervisor who can interest, stimulate and train the young engineers assigned to him.

Both can be equally effective—for the respective organizations.

"Training," says the engineering vice president of a Chrysler division, "is really just a state of mind. Basically, it's nothing more than creating an environment which will encourage the young engineer to strive for fulfillment, and then stimulate him to go ahead and develop himself professionally."

A good many executives of nontraining firms express the feeling that their companies just "couldn't afford" even to train their young engineers, let alone make special

#### "... training people all too often exhibit a profound incapacity for honest self-appraisal."

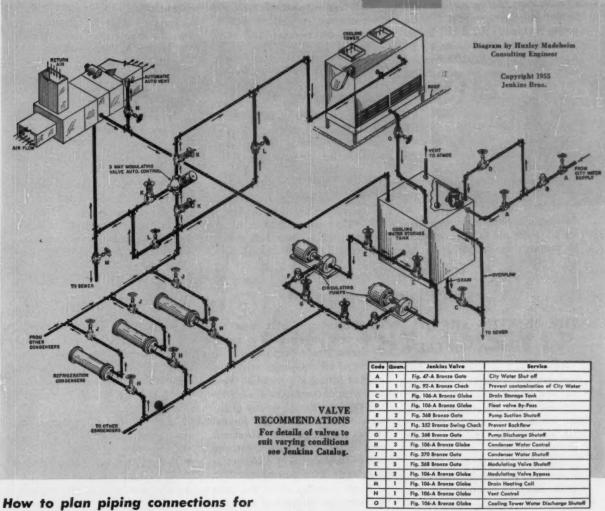
programs available to older men. Those who have programs, however, were nearly unanimous in saying that they "couldn't afford to be without them."

#### LIP SERVICE TO GROWTH

While the employers indicated that training is necessary for the

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Where continuous refrigeration is required, the heat absorbed by the water circulating through the condensers during the refrigeration cycle may be transferred to circulating air and used for space heating. This hookup illustrates a system that is widely approved for utilizing waste heat in frozen food plants, ice cream plants, supermarkets, and refrigerated warehouses.

A cooling tower for water conservation is included in the usual water cooling system for refrigeration condensers, as indicated. All or a portion of the water which usually flows through the cooling tower system may be diverted and circulated instead through a water coil in the summer air conditioning unit. A three way modulating valve, actuated by a room thermostat, controls the

water passing through the two parallel circuits, dividing it according to the heating requirements.

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The cooling tower circuit provides for water storage in a tank inside the building to avoid freeze-ups. The water circuits shown can be full weight red brass pipe, copper tubing, or black iron pipe.

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engineer to be of maximum value in the shortest possible time, PECBI avers that it isn't enough to train him for a specific job. "The young engineer," the Board holds, "must grow professionally to fit himself not only to master jobs of increasingly greater responsibility but to take his place in the community, a respected representative of his firm and his profession.

And, although both large and small plants insisted that their educational programs were directed toward the professional growth of their engineers, PECBI says that it's significant that by far the greatest support is given to courses on the specific applications of engineering principles and to those designed to provide the special types of

knowledge and skills for management posts.

Only a few companies were found to encourage cultural as well as technical development, and make

#### ". . . only a few encourage their engineers to develop culturally as well."

tuition refunds for liberal arts courses as readily as for those in science and engineering. This is criticized as failing to meet the needs of the individual.

#### WHAT IT RECOMMENDS

The PECBI wraps up its report by recommending that employers:

• Give more attention to supervision and guidance both during orientation and for several years thereafter. Programs should be planned and pathways for development charted.

 Present greater opportunities for advanced study. These should not be tied to courses relating specifically to the job.

 Cooperate with other plants, schools, societies and community groups to make the facilities now available to the large company open to the small.

 Interchange information about training methods and techniques.

 Develop programs which stimulate the engineer's interest in community and cultural activities.

Encourage professional registration and participation in professional society activities.

#### THE MONTHS AHEAD

#### ... For New ChE's

This month, a little over 2,000 new degrees in chemical engineering will be awarded. And in the months ahead the recipients can look to more and more interesting job opportunities at the highest starting rates ever.

Since last October, they've been wooed and pursued by more companies and more company recruiters then ever before. Competition grew so frantic that some colleges restricted the number of recruiters and the interview period so "the boys could be taught the senior year subjects."

Despite earlier feeling that starting rates were about to level off, the fierce competition resulted in another boost. In '54, new men averaged about \$365 to \$370 per month the start. Early reports indicate that this year's grads will launch their careers at a nationwide monthly average of over \$380.

▶ How High Is Up—The bulk of the class will start at from \$370 to \$390, but a good many command considerably higher. Earl C. Kubicek, placement director of Illinois Institute of Technology, reports an average starting rate of \$398 for IIT's fledgling ChE's-most of whom held summer jobs in industry during their college days.

Several oil companies start new men at from \$380 to \$420. And a number of companies in all fields pay well above \$425 to top graduates. The Wall Street Journal quotes a Carnegie Tech placement man as observing that in extreme cases "some bachelors could get as high as \$8,000 a year to start."

Many recruiters admit that some students are bargaining for, and getting, up to \$40 per month more than the original offer.

However, as one college spokesman told us "Few are choosing their employer solely on a salary basis." Training plans, initial job assignments, prospects for company expansion and chances for advancement swing plenty of weight in the graduate's decision.

The Cloud—Many graduates face a somewhat different employment problem. ROTC programs will claim about a third of the graduating class for a 2- or 3-yr. stretch in the service. The bulk of the remainder face an early draft call. And industrial deferments are harder to get—and to keep.

In service, the chances for young chemical engineers to get positions in which they'll use their training are pretty slim. Current minimum requirements for placement in the Army's Scientific and Professional Personnel Program include a BS and 3 yr. experience, or a masters and 1 yr. experience, or a PhD.

Once in the program there's still no assurance of a job which puts technical training to use.

► The Lining—For veterans and those exempted from military training the outlook couldn't be better.

As the manager of a large engineering personnel service notes: "In the \$4,500 to \$6,000 a yr. bracket there are 20 to 25 jobs for every man available."

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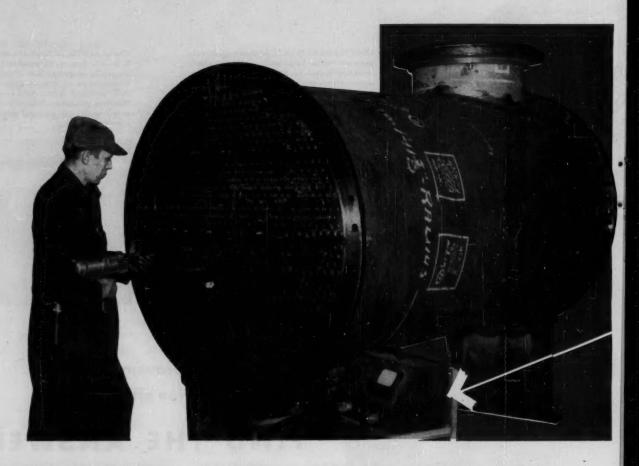
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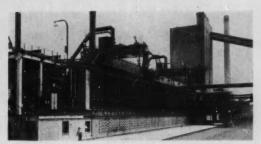
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	Max.	Rel.	RELATIVE RESISTANCE TO					
Material	Service Temp., °F.	Initial	Impact	Solvents	Salts	Alkalis	Acids	Oxidizing Acids
Epoxy-glass laminate	200	4	10	7	10	4	10	3
Carbon filled	200	5	3	7	10	5	10	3
Furan-glass laminate	250	8	7	9	10	5.	10	3
Cerbon filled	250	7	5	9	10	10	10	3
Impregnated graphite	340	1	6	10	10	10	10	5
Phenolic-laminate	250	5	7	9	10	3	10	4
Asbestos-filled	250	7	4	8	10	9	10	5
Polyester-glass laminate	150	10	10	6	10	1	6	4
Bisphenol modified	200	8	10	5	10	4	9	5
Thermoplastics Compo	red: (Ra	ting, 10=	=Best)					
Cellulose acetate butyrate	125	6	5	2	10	2	2	1
Polyethylene	(see text)	9	10	4	10	10	10	5
Polyfluorocarbons	450	1	8	10	10	10	10	10
Polyvinyl chloride, type I	150	5	2	6	10	10	10	7
Polyvinyl chloride, type III	140	5	9	5	10	9	10	5
Saran	150	3	2	6	10	9	10	6
Styrene rubber plastic	160	5	9	4	10	9	10	3

These properties form the basis of an . . .

#### **Optimistic Outlook for Plastic Valves**

Economics and serviceability of injection-molded globe valves mean much more extensive use in the future. Plastic diaphragm valves will continue to be popular.

#### R. B. SEYMOUR

Mechanical devices are no better than the materials used in their manufacture. Cast iron is completely suitable for some valve parts while others require expensive alloys. However, there are many places where no other available material is as satisfactory as plastics for the manufacture of various components of valves.

Before considering plastics for this application, the valve designer must know something about the physical and chemical properties of commercially available plastic materials. From the long term point of view, several new plastics now in laboratory test tubes and improvements of existing plastics still in development laboratories may change the present outlook. While the optimist knows that future plastics will replace many valve parts now being constructed from metal alloys, even those most critical of present day plastics must agree that the plastic materials now available show considerable promise for many applications in this field.

Specific thermosetting and thermoplastic materials have been used successfully as piping, valves, and ducts for over fifteen years. Both types of products have been used extensively for many years in Eu-

Ray Seymour is president of the Atlas Mineral Products Co., Mertztown, Pa. This article is based on his talk before the Valve Manufacturers Assn., New York, Sept. 14, 1954.

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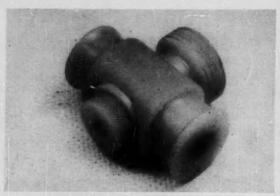
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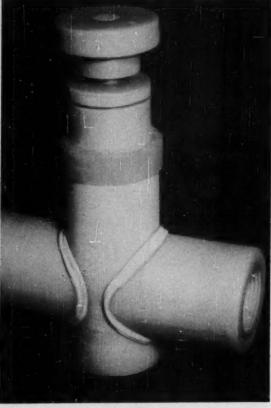
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Polyethylene plug valve.-(Fig. 1)



Saran plug valve.-(Fig. 2)



Polyvinyl chloride plug valve.-(Fig. 3)

rope but until recently, American experience was limited primarily to filled or laminated thermosetting plastics.

Most widely-accepted plastic valves to date are the diaphragm type. The popularity of this design will continue, but injection-molded globe valves will be used much more extensively in the future because of serviceability and economics.

A wide selection of appropriate plastic materials of construction is now available for valve manufacture. Proper attention to the physical and chemical properties of these products will aid engineers in the selection of the appropriate material for valves for any specific service.

#### Plastics for Valves

Epoxy Resins—Epoxy resins are prepared by reacting epichlorohydrin with bisphenol A, the product obtained by the condensation of

acetone and phenol. The product of greatest interest as a material for valve construction is that obtained by the reaction of appropriate polyamines with the epoxy resin. Carbon-filed epoxy resin has been used for casting Saunder's patent diaphragm valves.

Epoxy resins have excellent resistance to nonoxidizing acids, such as hydrochloric, phosphoric and dilute sulfuric. They are suitable for use with gasoline and benzene, but should not be used with acetone or chlorinated hydrocarbons.

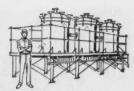
Furans—Carbon-filled furan resins were first introduced commercially in 1941. While their principle use has been in the form of chemical resistant cements, variations of these formulations have been used to form Saunder's patent diaphragm valves.

Furan resins have been manufactured from furfural, furfuryl alcohol, combinations of these two compounds or their reaction products with formaldehyde. Actually, there is little difference in the chemical resistance of these products.

Impervious graphite is produced by impregnation of formed graphite parts with catalyzed furan resins followed by polymerization in situ. They have outstanding resistance to all non-oxidizing corrosives and are used to some extent as valves.

Phenolic Resins—Cast phenolic asbestos mixtures, which were developed before filled furan resin structures, are formed by similar casting techniques. With the exception of their lack of resistance to alkalis, the physical and chemical properties of these materials are similar to comparable furan structures.

Polyesters — Polyester structures formed by the glass fiber reinforcement of solutions of unsaturated esters in styrene have been described quite thoroughly in many publications. In spite of their lim-





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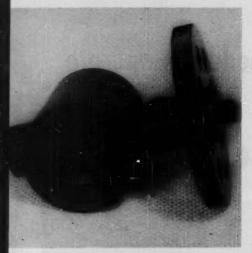
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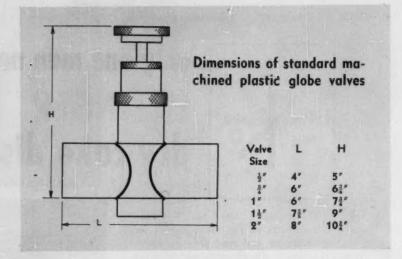
PVC globe valve.-(Fig. 4)



Metal-reinforced PVC "Y".-(Fig. 5)



Plastic globe valve from pipe.-(Fig. 6)



ited chemical resistance, these products have been promoted for use as valves. However, almost all commercial polyester resins produced prior to 1954 were attacked by acids and alkalis even at temperatures below 200 F.

More recently a polyester resin which combines the chemical resistance of epoxy resins and the low cost of polyesters has been introduced commercially. It consists of a styrene solution of an ester formed by the reaction of (1) fumaric acid with (2) the product obtained through the condensation of bisphenol A and ethylene oxide or propylene oxide.

Experimental valves fabricated from this improved glass fiber reinforced polyester resin are more resistant to chemicals than structures previously available. However, they are not completely resistant to alkalis or oxidizing acids.

Cellulose Acetate Butyrate—In spite of the fact that cellulose esters are attacked by almost all acids, alkalis and solvents, cellulose acetate butyrate pipe has been used successfully in many installations where superior chemical resistance was not essential. Molded cellulose acetate butyrate valves usually contain liquid plasticizers. Unless stabilized and pigmented with well dispersed carbons, this product is not recommended for outdoor exposure. However, valves molded from this plastic have shown prom-

ise when used in natural gas service lines. A cutaway section of such a valve is shown in Fig. 8.

Polyethylene - Polyethylene has the lowest specific gravity of any available plastic material. It is not attacked by non-oxidizing acids, salts or alkalis. Since it tends to swell at ordinary temperatures and dissolve at elevated temperatures in non-polar solvents, it is not usually recommended for solvent service. It has a coefficient of expansion of 9 × 10- in./in./°F. Maximum service temperature depends on end use. When not irradiated, it cannot be used continuously at temperatures as high as most other chemical-resistant thermoplastics.

Polyethylene is unsatisfactory for use in direct sunlight unless compounded with properly dispersed carbon black and suitable anti-oxidants. Considerable information on polyethylene fabrication techniques has been developed by the Polyethylene Task Committee of the Thermoplastic Structures Division of the Society of the Plastics Industry. A 1-in. polyethylene plug valve is shown in Fig. 1.

Polyfluorocarbons — Polytetrafluoroethylene and polymonochlorotrifluoroethylene are not attacked by solvents, acids, salts or alkalis even at temperatures as high as 400 F. Polytetrafluoroethylene withstands higher temperatures and is more resistant to hot concentrated nitric acid than polymonoCONTROL

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4-in. polyvinyl chloride "Y" valve.-(Fig. 7)



Cellulose acetate butyrate angle valve.-(Fig. 8)



Polytetrafluoroethylene valve with a metal casing.—(Fig. 9)

chlorotrifluoroethylene, but for simplicity the two materials will be discussed under one heading.

Polyfluorocarbons may be molded through the use of special techniques to produce valves or valve liners with exceptional chemical resistance. A proprietary polytetrafluoroethylene valve with a metal casing is shown in Fig. 9.

Polyvinyl Chloride—While millions of pounds of unplasticized polyvinyl chloride have been used successfully for twenty years in Germany, this product was not available in this country until about five years ago. Since its introduction to American industry, it has lived up to its European reputation as an outstanding material for valve construction.

According to the standards established by the Thermoplastic Structures Division of the Society of the Plastic Industry, the product comparable to the standard German material is termed Type I. It has an Izod notched impact resistance in the order of 1 ft. lb./in., and is resistant to all salts, alkalis and nonoxidizing acids at temperatures below 150 F.

While this impact value may appear to be extremely low, it is much higher than that of many standard materials of construction. For example, as shown in Fig. 14, Type I polyvinyl chloride may be crushed in a vise without cracking. A hard blow from a 10-lb. hammer is required to cause even the slightest fracture.

More recently, unplasticized polyvinyl chloride with an impact resistance greater than 5 ft. lb. per inch of notch has been introduced. One of these products is a blend of polyvinyl chloride and acrylonitrile rubber. These products, which are classified as Type III, are slightly less resistant to chemicals than Type I but are satisfactory for use with many corrosives. For simplicity, both types will be discussed together.

Saunder's patent valves with flexible diaphragms have been molded from Types I and III polyvinyl chloride. As might be predicted, the flexible diaphragm (if other than polytetrafluoroethylene) is

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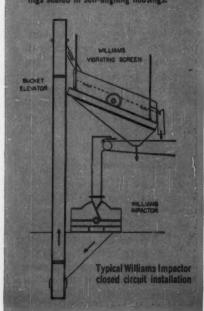
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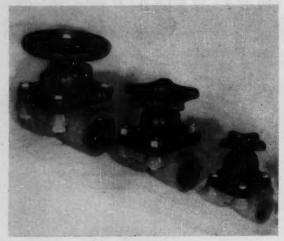
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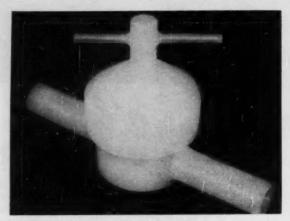
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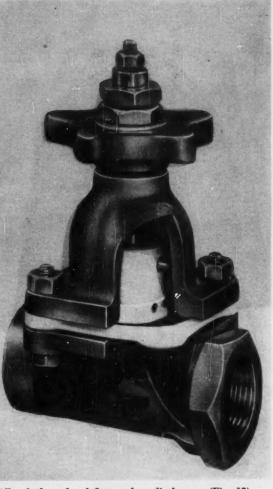
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Saran diaphragm valves.-(Fig. 10)



Polyethylene diaphragm valve.-(Fig. 11)



Alloy body and polyfluorocarbon diaphragm.-(Fig. 12)

often attacked by oxidizing liquids but can be readily replaced.

As shown in Fig. 4, 1-in. globe valve having excellent chemical resistance throughout has been machined from polyvinyl chloride rod stock. Considerably larger polyvinyl chloride valves have been fabricated in Germany. A 4-in. valve of this type is shown in Fig. 7. Attempts have also been made to adapt transfer-molded tees to the fabrication of valves.

A 1-in. metal-reinforced polyvinyl chloride valve molded in Germany is shown in Fig. 5. Considerable progress is now being made in attempts to injection-mold 1 and 2-in. polyvinyl chloride "Y" valves. As might be expected, when perfected, injection-molding tech-

niques will reduce the cost of such valves to the point where they may be considered as expendable items in chemical processing plants.

Saran — Saran has a relatively high specific gravity and is resistant to many salts and acids at temperatures up to 150 F. It is attacked by chlorine, ammonia, organic amines and nitric acid. It was one of the first chemically-resistant plastics to be molded and is still used to some extent for the manufacture of bodies of Saunder's type valves. A fabricated plug valve of this plastic is shown in Fig. 2.

Styrene Rubber Plastics — Styrene rubber plastics are resistant to salts, alkalis and nonoxidizing acids at temperatures up to 150 F. They are less resistant than poly-

vinyl chloride to oxidizing agents. This type of material has been molded to form the Saunder's patent diaphragm type valve. Saran diaphragm valves of varying sizes are shown in Fig. 10. A complicated molded rubber plastic valve used with water softening equipment is shown in Fig. 13.

#### Plastic Valve Construction

To secure the full advantage of plastic pipelines, it is essential that valves be available with physical and chemical properties comparable to that of the pipeline material. Fortunately, simple valves can be produced from almost every plastic used for the manufacture of pipe.

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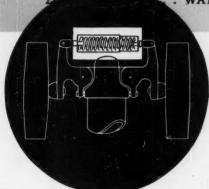
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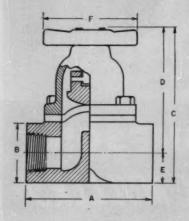
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#### Dimensions of diaphragm valves

Size	A	В	c	D	E	F	Approx. Wt., Lb.
1"	21"	15"	3}}"	3"	31"	21"	1.6
1"	31"	130"	45"	317"	35"	21"	2.0
1"	5"	21"	517	311	110"	3"	3.5
11"	5"	21"	5 12"	437	116"	3"	3.2
11"	51"	21"	6"	418"	14"	5"	5.7
2"	7"	3"	74	518"	13"	6"	9.3

As might be expected, plastic butterfly valves, slide dampers and louvers have been manufactured as standard items for plastic fume exhaust systems. However, the manufacture of valves for fluid systems is relatively new and has been limited primarily to plug, needle, globe valves—and diaphragms for low pressure service.

Plug Valves—First plastic valves were an adaptation of glass stop-cocks. As in the case of their glass counterparts, these valves opened or closed by means of a 90° handle movement. Plastic plug valves can be used to throttle liquid flow, but are not suitable for pressures above 5 psi.

Plug valves have been machined from saran, unplasticized polyvinyl chloride, polyethylene, styrene rubber plastic and cast thermosetting plastics. A 3 in. saran and polyvinyl chloride plug valve is shown in Fig. 3.

Silicone greases and dispersions of polyfluorocarbons have been used successfully as lubricants for plug valves. While the plastic material itself may be completely resistant to the fluid, some lubricants may be attacked and contaminate the liquid in the pipeline.

As might be anticipated, an allplastic polyfluorocarbon valve does not require any lubricant. However, because of the high cost of this product, it has been customary to use it as a liner in metal plug valves. Valves of this type do not stick even at pressures as high as 800 psi. and operate satisfactorily at temperatures as high as 350 F.

In addition to its application as a valve liner, polytetrafluoroethylene or mixtures of this plastic and asbestos have been used for valve packing and seats.

Polyfluorocarbon packing and seats have also been used in porcelain and stoneware valves. It is customary to armor these valves with glass fabric-reinforced epoxy resins to increase their resistance to mechanical damage.

Globe Valves—First thermoplastic globe valves were machined from molded blocks of unplasticized polyvinyl chloride. Similar techniques have been used with polyethylene, saran and styrene rubber plastics. In recent years, this type valve has been produced through the use of machining and welding techniques.

Because of multiple changes in the direction of fluid flow, considerable turbulence is developed. There is also a relatively high pressure drop, and this type valve should not be used with slurries or liquids containing undissolved solids. In spite of the disadvantages inherent in globe valve design, most plastic valves in the future will probably be variations of standard globe valves. Globe valves have been fabricated from saran, polyethylene, styrene rubber plastics and unplasticized polyvinyl chloride. These valves (which are available in this country in sizes up to 2 in.) have dimensions as shown in the table. Valves of this type should not be used with pressures greater than 50 psi. nor at temperatures above 150 F. As shown in Fig. 6, plastic globe valves can also be fabricated from plastic pipe.

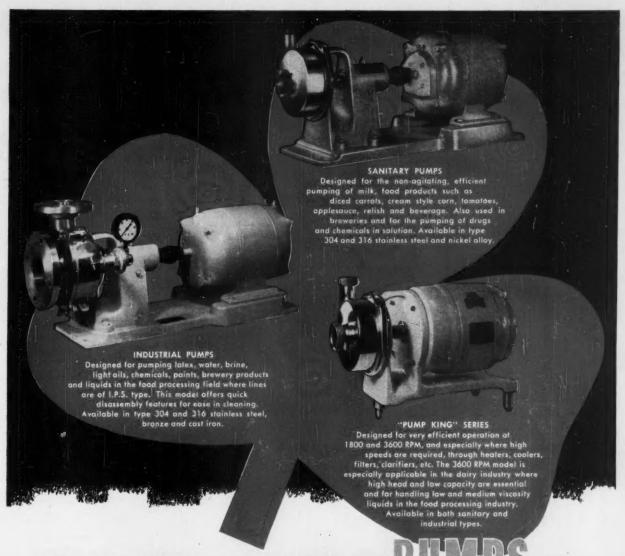
#### Maximum Working Pressures, Psi.

(Saunders's Type, Molded Plastic Bodies)

	Plastic Bodie	28)
Size	70 F.	150 F
1"	150	150
1"	150	150
1"	150	125
11"	150	100
14"	150	90
90	150	75

Diaphragm Valves—Unite the plastic valves discussed previously, pinch clamp valves require a flexible tubing and have no metal counterpart. This principle has been used to produce the well known diaphragm valve commonly referred to as the Saunder's type valve.

This valve has many variations. The bottom is usually metal and the diaphragm is always made from flexible plastic or rubber. The body may be either metal or plastic. The valve shown in Fig. 12 has an alloy body and a polyfluorocarbon diaphragm. An all-plastic Saunder's



### 

ANY product that will flow to them can be handled efficiently and economically with Tri-Clover non-agitating centrifugal pumps. Illustrated are just three of the many Tri-Clover pump models used extensively in food processing, brewing and bottling, chemical process and general industrial applications. Pumps are available in stainless steel, nickel alloy, bronze and cast iron.

Designed for efficient liquid transmission and low cost maintenance, these pumps have many exclusive features, among which are—patented screw type impellers with quick-acting impeller clips, lightweight heads with a minimum of parts, casing construction permitting fast, easy assembly or disassembly—and a wide choice of seals for various applications,

including inert carbon rotary seals for sanitary application, packing gland seals, water cooled seals and seals for latex handling.

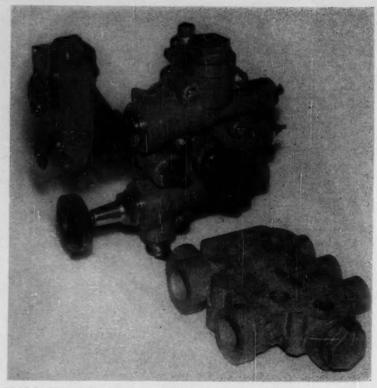
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TRI-CLOVER



Molded rubber plastic valve for water softening equipment.-(Fig. 13)



Type I polyvinyl chloride may be crushed in a vise without cracking.-(Fig. 14)

type valve fabricated from polyethylene is shown in Fig. 11.

Non-plastic bodies have been cast from iron, stainless steel, Monel, nickel, Hastelloy B and C, lead, aluminum, tin and many alloys. Cast iron bodies have been lined with soft rubbed, neoprene, glass, vitreous enamel, porcelain, zinc, backed phenolic, saran rubber, saran, polyethylene, polyfluorocarbon polymers and various protective coatings. Bodies have also been cast from asbestos-filled phenolics and furan plastics. Bodies have been molded from saran, styrene rubber plastic and unplasticized polyvinyl chloride.

Diaphragms have been constructed from natural rubber, neoprene, butyl rubber, acrylonitrile rubber, saran rubber, styrene rubber, plasticized polyvinyl chloride, polyethylene, polyvinyl alcohol and polyfluorocarbon polymers.

#### ACKNOWLEDGMENT

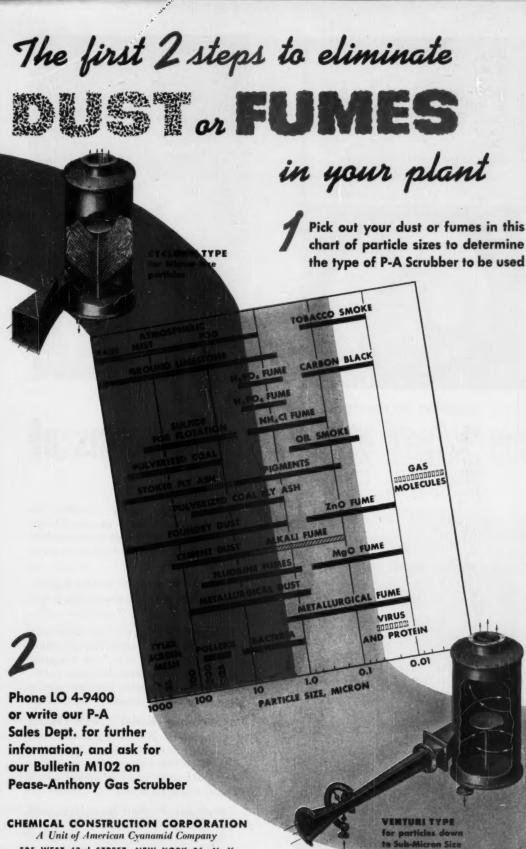
Assistance of the following who supplied valve samples used for the accompanying photographs is gratefully acknowledged:

American Hard Rubber Co., Douglas Williamson
Bolta Products, George S. Laaff
Chicago Die Mold Div., U. S. Rubber
Co., Dr. B. W. Bender
E. I. du Pont de Nemours & Co.,
J. J. Ondrejein
Goodrich Chemical Co., R. T. Holtz
H. N. Hartwell & Son, Inc., Laurence
N. Thomas
Hills-McCanna Co., R. McFarland
The Lindsay Co., Lynn G. Lindsay
Mueller Co., R. K. Levey
The Nalge Co., Emanual Goldberg
Prodorite, Ltd., Wednesbury, Staffs,
England, V. Evans
Resistofiex Corp., Al St. John
Tenaplas, Ltd., London, S.W.I., England, H. S. Cheney

#### NEXT MONTH:

#### VERSATILE NEW ALLOY

A new nickel alloy developed by International Nickel Co., that has as its outstanding characteristic the ability to resist both severe oxidizing conditions and severe reducing conditions, will be described in next month's Corrosion Forum. Called Nionel, its composition is comparable to that of the 20 alloy, being approximately the same in chromium but somewhat higher in nickel. It is available in a variety of wrought forms.



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-



# Think "BIGGER"

You have a large range of pipe sizes to work with in Inco Nickel Alloys and up to 9¼ in. O.D. in extruded tubing.

	RAN	GE OF SIZES	
Product	Alloys*	Diameter	Wall
Seamless	A	16" to 8" IPS )	
Pipe		14" to 6" IPS	Sched. 5-10-40-80
Seamless and	A	15" to 814" 00	0.025" to 0.500"
Condenser Tubing	8	1/2" to 6" OD	0.035" to 0.259"
Extruded	A	21/2" to 914" 00	14" to 16"
Tubing		21/2" to 81/2" 00	1/4" 10 36"
Small diam. Tubing	All	0.012" to 0.625"	0.0015" to 0.010"
Cast Threaded Fittings	All	For IPS 46" to 6"	
Wrought Welded Fittings	AH	For IPS V2" to 12"	

\*A: Monel, Nickel B: Inconel, Incoloy, Nionel

### Think "smaller"

Unusually small sizes available, too. The tube, world's smallest, shown here in comparison with a fly wing was drawn by Superior Tube Co. from Inco Nickel.



## Think "STRONGER"

Given Inco Nickel Alloy strength and corrosion resistance, you can often use thin, light, low-cost Schedule 10 piping.

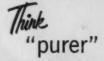
#### BURSTING PRESSURES\* (p.s.i.)

IPS	OD	ID	Nickel	Monel	Inconel
1/2"	.840"	.674"	10,870	13,840	15,815
1"	1.315"	1.097"	9,120	11,610	13,270
11/2"	1.900"	1.682"	6,310	8,035	9,180
2"	2.375"	2.157"	5,050	6,430	7,350
3"	3.500"	3.260"	3,770	4,800	5,485
4"	4.500"	4.260"	2,935	3,740	4,270

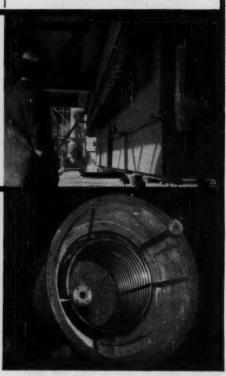
\*Data base: Annealed pipe (Min.tensile strength, p.s.l.: Nickel, 55,000; Monel, 70,000; Inconel, 80,000), and for temp. up to 500°F. When estimating safe operating pressures, apply safety factors customary for particular service.

### Think "HOTTER"

Inconel and Incoloy take you way up the temperature scale . . . provide protection against corrosion and high-temperature deterioration. These Incoloy burners in a gas reformer operate at temperatures up to 1700°F.



To hold metallic pick-up way down, many processors use nickel...as in this patented caustic cooler used in rayon, soap and similar plants . . . as used in food machinery, too.





# Think in terms of

Consider your piping. Consider the corrosives it handles . . . the special conditions of temperature, pressure, product purity. Consider its fabrication . . . sizes, forming, joining.

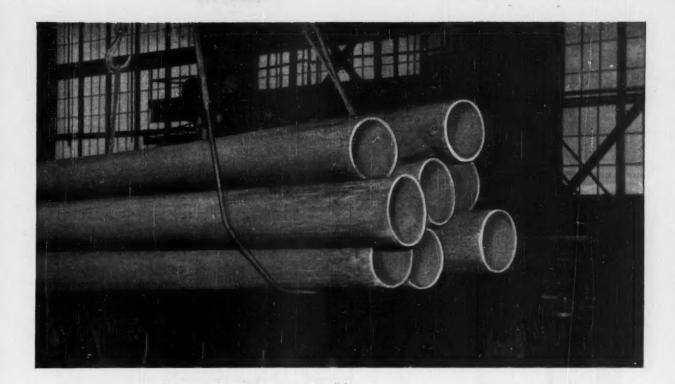
In all these areas, Inco Nickel Alloy pipe and tubing give you sweeping design latitude.

Alloys? For reducing environments, you have Monel. For outstanding product purity, Nickel. For very high temperatures and tough stress-corrosion conditions, Inconel or Incoloy. For other needs, other Inco Nickel Alloys.

Now comes Nionel ... Inco's latest development. Nionel is a new nickel-chromium alloy containing molybdenum and copper. It resists severe corrosives ... certain hot acids, many oxidizing chemicals, most organic acids.

Nionel and the other Inco alloys resist broad groups of corrosives. They are





# Inco pipe and tubing to resist corrosives

particularly useful for heat exchangers and other equipment where there is one corrosive outside, another inside (as when using chloride-containing cooling waters).

Fabrication? You can design with a free hand. Bending, cutting, threading are no problems. You have good welding properties, and welding fittings are readily available. As for sizes, see the list top left.

But that's not all. Notice the possibilities for light-weight, thin-wall, low-cost construction in the figures on bursting strengths given above left for Schedule 10 piping.

No question about it. When you want piping to resist corrosives, it pays to think in terms of Inco Nickel Alloy pipe and tubing.

THE INTERNATIONAL NICKEL COMPANY, INC.

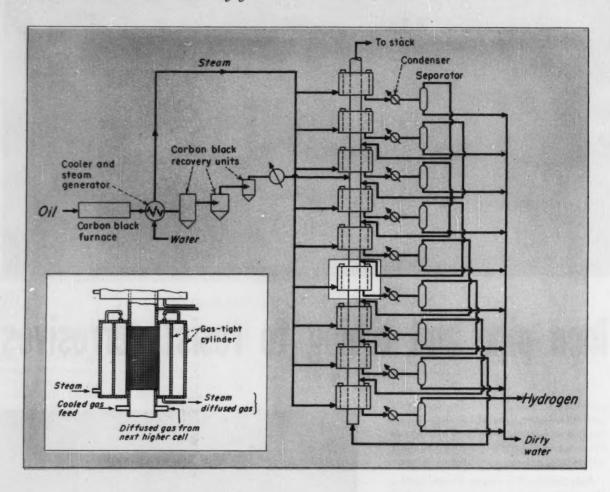
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### Tomorrow's Technology Melvin Nord, Chemical Engineer & Patent Attorney, Detroit, Mich.



### **New Wrinkle in Gaseous Diffusion**

The combined action of molecular effusion and thermal diffusion is responsible for the effective separation of gases in this new diffusion process.

Combine molecular effusion with thermal diffusion and you have the crux of this new diffusion process for separating gases.

How does it work? Here's a typical application—the recovery of hydrogen from the off-gases of a furnace carbon black plant.

Cooled flue gas, free of suspended carbon black particles, feeds to a battery of diffusion cells containing porous membranes—e.g. unglazed porcelain, fine mesh wire, thin-walled perforated metal plate. Each cell membrane is cylindrical and surrounded by a pair of gas-tight cylinders.

Molecular Effusion—Steam feeds into the outer annulus of each cell, through external pipes and into the inner annulus. It exits with gas which has diffused into it. Undif-

fused gas flows to the next higher cell in the battery.

Hydrogen diffuses through the cell membrane at a rate which is  $(28/2)^{0.5}$  or 3.74 times that of carbon monoxide,  $(44/2)^{0.5}$  or 4.69 times that of carbon dioxide,  $(18/2)^{0.5}$  or 3 times that of water vapor. Thus the battery of cells, operating on the principle of molecular effusion, provide considerable gas separation.

► Thermal Diffusion—For more complete separation, thermal diffusion picks up where molecular effusion leaves off.

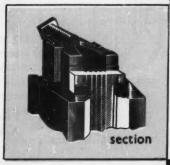
The inner gas-tight cylinder of

# THE LEVEL BEST

Klinger "K" Type Reflex Level Gages have the following outstanding advantages: —

Single row of tightening bolts. Body free from distortion. Glass easily removed. Gage body turnable, free to expand, and easily removed.

The "K" Type Gage is made in a wide variety of sizes and any number of bodies can be combined to provide level indicators of any length.



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each cell is heated—by high-temperature steam—to 600-700 C. The large temperature gradient set up across the porous membrane directs low-molecular weight gas (hydrogen) toward the hot area, increasing the rate of hydrogen diffusion.

Steam also acts as a carrier for the removal of diffused gas—to prevent the build-up of high gas concentrations which might interfere with diffusion through the membrane.

Cooled exit gas from each cell

passes through a condenser, into a separator from which condensed steam is removed. Uncondensed gases exit from the top of the separator, flow into the feed line, then enter the next lower cell.

Hydrogen gas (product) accumulates at and exits from the bottom of the battery. Other gases pass up through the battery and exhaust to the stack.—U. S. 2,699,836 by Hugh M. Barton, Jr. to Phillips Petroleum Co.

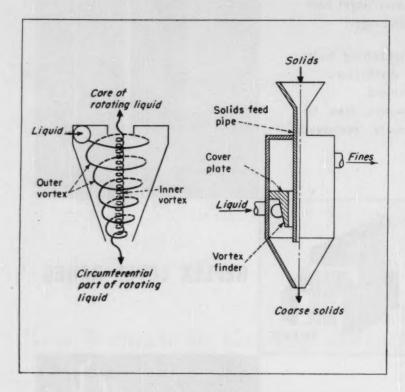
particles of high settling rate to remain in the circumference of the liquid; those of low settling rate drift toward the core.)

► Typical Example—Let's take a look at one of several separators which put this innovation to work:

As shown above (right), liquid enters the conical cyclone through a tangential feed line; solids feed into the center. A short pipe or vortex finder separates the inner and outer vortices.

The rotational speed in the center of the cyclone becomes so great that an air-filled core forms—extending from the base outlet to the top outlet. To prevent the mixture from escaping through the bottom, the cyclone is usually inclined at an angle to the vertical. (This precaution need not be taken if the cyclone is cylindrical. For in cylindrical cyclones, the top opening is not in the separator's axis, but in the periphery. And there's no fear that the axially supplied mixture will fall out of the cyclone.)

Due to high speeds developed and the correspondingly great forces acting on the solids, gravity plays no part in the separation.—U. S. 2,700,468 by Freerck Jan Fontein to Stamicarbon N. V.



#### **New Approach to Solids Separation**

Sharper fractionation results from the axial introduction of solids into a cyclone separator.

A switch in introducing solids into a cyclone separator is the key to sharper fractionation of solids, says Stamicarbon N. V. In its improved separator, solids feed in axially (rather than tangentially) at the top. But liquid feeds in tangentially—in the conventional manner. The result: displacement of solid

particles—in radial direction—is the reverse of conventional operation. That is, particles of low settling rate remain in the fluid core while particles of high settling rate are thrown out—by centrifugal force—toward the liquid's circumference. (In conventional operation, tangential introduction of solids causes

#### Fractionating Fatty Acid Monoglycerides

Contrary to general belief, fatty acid glycerides—i.e. the more unsaturated monoglycerides — form crystalline urea complexes. And Shell Development Co. makes use of this principle to:

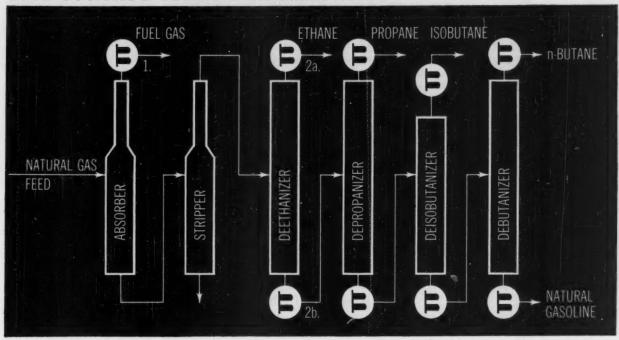
 Separate monoglyceride mixtures into their saturated and unsaturated components.

 Make available those monoglycerides (with two or more double bonds) which have the drying characteristics desirable in alkyd resin

manufacture.

Briefly, the process involves the

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### TRI-NON'S Up Efficiency in Light Hydrocarbon Separations

It is simple to produce high product purity in light hydrocarbon separations, but only at the expense of percent recovery, or to obtain 100 percent recovery at a sacrifice of purity. But operating *profit* depends upon the ability to obtain a maximum of both product purity and percent recovery. Close control of the process environment: temperature, pressure, flow rate, is not sufficient since environmental controls do not give any indication of stream composition.

The best way to insure maximum returns for *both* is to analyze continuously the separator tower overhead and bottoms.

TRI-NON Analyzers installed at critical points in the process, as indicated in the above diagram, monitor the concentration

of the important components.

Analyzer 1 measures the concentration of hydrocarbons heavier than methane in the absorber overhead to check absorber efficiency. Analyzers 2a and 2b indicate ethane purity and ethane loss in the bottoms. The remaining analyzers perform the same functions on the other towers. The data provided permit operation at the most profitable level at all times.

In light hydrocarbon separation as well as in practically all other chemical processing—True Control Begins with Analysis. Perkin-Elmer's continuous infrared analyzers can provide the ANALYTICAL CONTROL essential for most profitable operation. Perkin-Elmer engineers can show you how analytical control can be applied to your process.

\*TM The Perkin-Elmer Corp.



Both the TRI-NON and BICHROMATOR Analyzer continuously record the concentration of any desired stream component. Each is sensitized and adjusted to specific plant conditions before shipping.

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PERKIN ELMER — FIRST IN ANALYTICAL CONTROL

(1) conversion of naturally occurring mixtures of triglycerides to the monoglycerides, (2) reaction of the monoglycerides with an alcoholic urea solution, (3) formation of urea complexes with the more saturated fatty acid monoglycerides.

Numerous examples, cited in the patent, describe how the fractionation is carried out.—U. S. 2,700,036 by Theodore F. Bradley, Albert C. Mueller and Edward C. Shokal to Shell Development Co.

#### Ketone Addition Makes For Better Detergents

In the dark when it comes to preparing detergent sulfonates which are free of unreacted saturated hydrocarbons and have better wetting properties? Here's a process which may shed some light on the subject.

According to the inventor, the extraction of unreacted hydrocarbons is facilitated by the addition of a water-soluble ketone to the sulfonation product's alkali salt.

This is how it's done. Hydrocarbon feed (a mixture of C<sub>a</sub>-C<sub>1a</sub>) and sulfonating agent (sulfuric, fuming sulfuric, aceto-sulfuric or chlorosulfonic acids) are reacted-below 45 C.—in a sulfonating zone. The ratio of sulfonating agent to feed varies from 1.3 to 1:1, depending upon the amount of unsaturated hydrocarbon in the feed.

- Base-Ketone Added—Sulfonated oils (containing unreacted saturated and unsaturated hydrocarbons) are then reacted with an aqueous solution of base and ketone—to neutralize the oils and convert them to their corresponding salts. A variety of inorganic and organic bases can be used. Preferred ketones are acctone and/or methyl ethyl ketone (10-60 yolume %).
- Extracting Impurities—Once the oils and base-ketone solution are thoroughly mixed, a light hydrocarbon is added to extract unreacted material. Or, if preferred, the oils can be neutralized with base, then agitated with a mixture of water-soluble ketone and light hydrocarbon.

After the addition of extracting solvent, the mixture goes to a sepa-

rator. Here two layers form—the upper, oil; the lower, aqueous. The upper layer (solvent and unreacted hydrocarbons) is withdrawn for further processing. The lower layer (aqueous solution of water-soluble salts of the sulfonation product plus ketone) goes to a stripper.

Ketone leaves the stripper as overhead. Purified salt solution, withdrawn as bottoms, can be stored or spray dried—to recover solid detergent.

Several detailed examples of the process are cited in the patent.— U. S. 2,700,052 by George P. Lauer to The M. W. Kellogg Co.

#### New Device Collects Atmospheric Pollutants

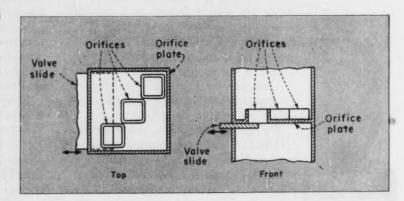
The mounting interest of municipal and civic organizations in factors influencing atmospheric contamination has given impetus to the development of tools for solving air pollution problems.

One of the newest of these is a device which collects and segregates solids or gases—two primary atmospheric contaminants—according to the wind's velocity and direction.

Simple Turntable—Basically the device consists of an outer shell-type housing, a number of collecting jars mounted on a rotating platform, fins which align with the wind direction and flap valves which open only when the wind velocity exceeds a preset value.

The apparatus is usually left untouched for a period of thirty days. Jars are partially filled with water so that any solids collected in them will be retained. At the end of the thirty-day period, the housing and jars are removed. Solids collected are weighed and analyzed.

The collector can also be used to sample gases in the atmosphere.—U, S. 2,699,679 by Hamnett P. Munger to The Battelle Development Corp.



### **Novel Valve Regulates Solids Flow**

Compensation for crosion is the highlight of this new slide valve design. For, as one area of the valve slide becomes eroded, the slide can be moved to a new position so that an uncroded surface is exposed.

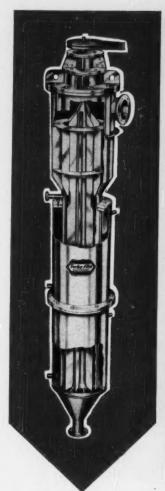
As shown, the valve consists of a square orifice plate containing three orifices. The plate is directly above the valve slide.

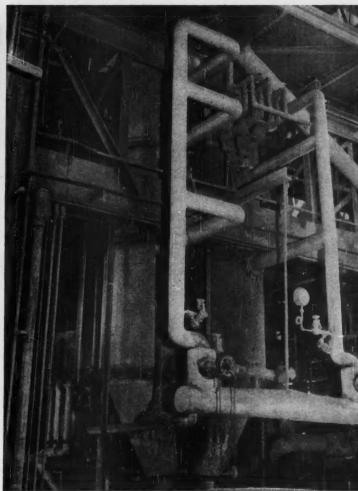
As the edge of the valve slide wears away, the slide is simply

moved forward—to compensate for the erosion. And when erosion of the slide is such that it creates an opening in the slide equal to the size of the first orifice, the slide begins to close the second orifice.

Further movement of the slide therefore makes it possible to continue to regulate the flow of solids.

-U. S. 2,696,362 by Lester M. Craig and Cecil D. Bush to Standard Oil Development Co.





At left—two of four No. 5 Turba-Film Evaporators at Allied Chemical & Dye's South Point, Ohio, works.

# Abrasive fertilizer slurry is rough test of TURBA-FILM® EVAPORATORS

Four Rodney Hunt No. 5 Turba-Film Evaporators working under the most difficult conditions are used in the production of Arcadian 12-12-12, a new and highly efficient chemical fertilizer manufactured by Allied Chemical & Dye Corporation.

The fertilizer is made at Allied's South Point, Ohio, plant. The various chemical ingredients are mixed to form a slurry which must then be reduced to uniform granules of low moisture content. Turba-Film evaporators were found capable of reducing moisture content from approximately 20% to 6% at high production rates.

Although the evaporation takes place at high temperature and under exceedingly abrasive conditions, the four Turba-Film Evaporators handle the entire capacity of the company's production line.

If you have a problem of moisture or solvent removal from liquids, pastes, or slurries, write to Rodney Hunt for information on the efficient Turba-Film Evaporator and the Rodney Hunt-Luwa Spray Dryer.



RODNEY HUNT MACHINE CO.

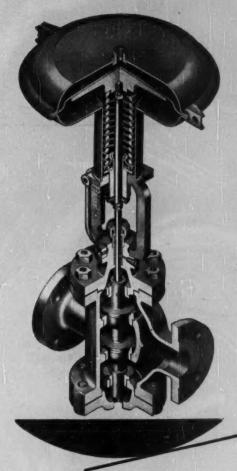
MANUFACTURING ENGINEERS SINCE 1840

### Your Checklist of New Equipment Patents

About				
Chemical reaction.   Apparatus for synthesis of organic epds   The M. W. Kellogg Co.   2,699,988	Operation	About	Inventor or Assignee	Patent No.
Crushing and grinding	Adsorption		Phillips Petroleum Co	2,700,061
Distillation	Chemical reaction	Apparatus for synthesis of organic cpds Apparatus for contacting vapors with fluidized		
Distillation	Crushing and grinding			
Drying	Distillation	Lightweight fractionating tray  Device for determining the level of a volatile	Socony Vacuum Oil Co. Inc	
Extraction			Air Products, Inc	2,701,710
Extrusion and molding	Drying	Drying by atomisation	Josef Jehlicka	2,699,822
Extrusion and molding	Extraction		Metallgesellschaft A. G	2,701,753
Filtration	Extrusion and molding			
Heat transfer. Pebble heat exchanger. Phillips Petroleum Co. 2, 699, 987 Instrumentation and control Gas-flow measuring device. Hans Gebre. 2, 699, 678 Direct-reading viscometer. Sec. of the Navy. 2, 700, 891 Solid-gas separation. Electrical precipitator. Research Corp. 2, 701, 028 Recirculating cleaning air in a precipitator. The Air Preheater Corp. 2, 701, 622 Solid-solid separation. Drum separator for beneficiating minerals Western Machinery Corp. 2, 700, 436 Cyclone-type separator. Thomas R. Morton. 2, 701, 056	Filtration	Pulp-circulating vacuum filter		2,699,872
Instrumentation and control   Gas-flow measuring device   Hans Gebre.   2, 699, 678	Heat transfer.			
Solid-gas separation. Electrical precipitator. Research Corp. 2,700,429 & 2,701,028  Recirculating cleaning air in a precipitator. The Air Preheater Corp. 2,701,622  Solid-solid separation. Drum separator for beneficiating minerals. Western Machinery Corp. 2,704,466  Cyclone-type separator. Thomas R. Morton. 2,701,056	Instrumentation and control	Gas-flow measuring device	Hans Gehre	2,699,678
Recirculating cleaning air in a precipitator. The Air Preheater Corp. 2,701,622 Solid-solid separation. Drum separator for beneficiating minerals. Western Machinery Corp. 2,700,486 Cyclone-type separator. Thomas R. Morton. 2,701,056	Solid-gas separation			2,700,429 &
Cyclone-type separator	S. N.J. and J. and A. a			2,701,622
	Solid-solid separation	Cyclone-type separator	Thomas R. Morton	2,701,056

### ... And New Process Patents

Product	Process	Inventor or Assignee	Patent No
Fate and oils	Curing synthetic drying oils	Standard Oil Development Co	2,701,780 2,701,810
Fuels	Gasification of carbonaceous solids	Hydrocarbon Research, Inc	
	Natural gas substitute from gas oil		
Gases	Hydrogen manufacture	Phillips Petroleum Co	2,699,986
	Fractional separation of air	The British Oxygen Co. Ltd	2,700,282
	Chlorine purification	Diamond Alkali Co	2,700,431
	Manufacture of soetylene	Knapsack-Griesheim A. G	2,701,188 & 2,701,190
Hydrocarbons	Distillation of high-boiling hydrocarbons	Carl Naumann	2,700,016
	Fluidized distillation of oil shale	Standard Oil Development Co	2,700,018 & 2,701,787
	Aromatics from petroleum via combination cracking process	Sinclair Refining Co	2,700,638
	Separation of p-xylene by crystallisation	Imperial Chemical Industries Ltd	2,701,266
Inorganic chemicals	Phosphoric acid production	Industrial & Financial Assn., Inc	
		E. I. du Pont de Nemours & Co	
Organic chemicals	Acetals from acid balides		
	Recovery of perfluorocarbon cpds	Phillips Petroleum Co	
	Producing p-xylene by chilling	California Research Corp	
	Chlorinating methyl aromatic cpds	Hooker Electrochemical Co	2,695,873
	Chlorination of ethylene polymers	Farbenfabriken Bayer A. G	2,695,899
	Ethyl alcohol purification	E. I. du Pont de Nemours & Co	2,696,463
	Maleic acid dehydration	Monsanto Chemical Co	
	Preparation of toluic acids	Richfield Oil Corp	2,696.499
	Benzoyl fluoride preparation		
	Crystallization of pentaerythritol		
	Bensene hexachloride production		2,696,509
	Polyvinyl alcohol production		
	Manufacturing monoacyl acetyl epds. of primary amines	Ciba Ltd	2,700,037
	Aqueous hydrolysis of flavanone glycosides	Sunkist Growers, Inc	2,700,047
	Producing organometallic cpds	Farbenfabriken Bayer A. G	2,700,048
	Isolating amino acids	The Dow Chemical Co	
	Preparation of ethylene sulfonamides	Monsanto Chemical Co	2,700,055
	Production of guanidine thiocyanate	Otto Grossinsky et al	
	Recovering paranitrochlorobensene	American Cyanamid Co	2,700,060
	Separating organic cpds. by adduct formation	Phillips Petroleum Co	
	Disproportionation of mono- and di-tertiary butylbenzenes	Standard Oil Co. (Ind.)	2,700,689
	Separating alcohols and other impurities from ketones	Shell Development Co	2,701,264
	Glycols and esters from partial oxidation of clefins	Houdry Process Corp	2,701,813
Rubber	Reclaiming unvulcanized rubber scrap	Dasher Rubber and Chemical Co	2,701,268
Synthesis gas and products	Recovering oxygenated organic cpds	Ruhrchemie A. G	2,696,493
	Extraction of water-soluble organic acids	Stanolind Oil & Gas Co	
	Separating oxygenated organic cpds	Phillips Petroleum Co	2,696,495
	Synthesis of oxygenated organics		
Synthetic fibers	Start-up polymerisation of acrylonitrile		
	Synthetic filament from the reaction of unsatu- rated cpds. with inorganic acid cpds.		2,695,834
L V	Producing rough-surfaced filaments of synthetic polymers	E. I. du Pont de Nemours & Co	2,695,835
	Spinning acrylonitrile	Eastman Kodak Co	2,697,023



# the valve that LIKES TO BE COMPARED

Is a valve positioner always required?

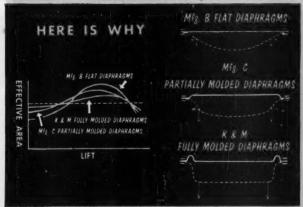
K & M provides 20-40% less positioning error. Often the need for a valve positioner is eliminated . . . because the K & M fully molded diaphragm gives the most constant effective diaphragm area.

K & M precision positioning also derives from long stem travel... lift that equals or exceeds any comparable valve... plus the highest power factor in the industry.

Behind it all lies one fact: K & M Control Valves are not adapted to high lift, they are designed for it. Throughout the entire range of valve travel... positioning is accurate and undistorted... control increments are finer with minimized positioning error.

Write for the K & M Valve Data Catalog, Bulletin CV-53.

77th Anniversary . . , Oldest U. S. Pressure and Level
Control Valve Manufacturer



With K & M fully molded diaphragms, virtually all components of force are vertical. Added to this, K & M gives the highest power factor (diaphragm area x lift) for precise valve positioning.

diaphragm control valves

KIELEY & MUELLER, INC.

64 GENUNG STREET, MIDDLETOWN, NEW YORK





### FACT:

# The new <u>life-Line</u> A has stronger insulation than any other motor on the market

Meaning what? Simply that the new Westinghouse Life-Line® "A" motor with new fortified insulation can withstand heavier overloads and operate at higher temperatures than any other motor you can buy.

Similar design advances in the mechanical and lubrication systems make Life-Line "A" industry's most preferred motor.

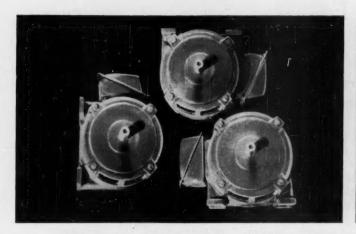
It takes the right combination of all three systems—electrical, mechanical and lubrication—to build the best package of power on the market.

Get all the facts by calling your Westinghouse sales engineer..:

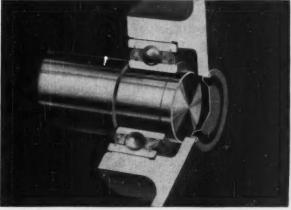
The Man With The Facts!

J-21877

# Westinghouse Westinghouse

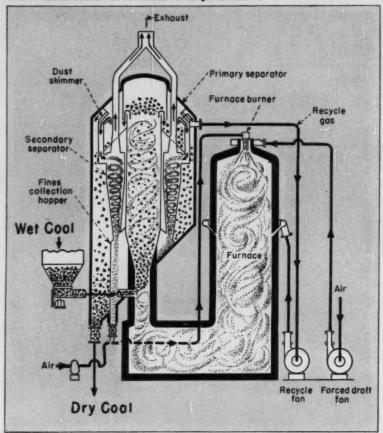


Mechanical System Fact: New cast-iron housing on both drip-proof and totally-enclosed types. Ventilation openings only in end brackets make the motor dripproof whether mounted on floor, ceiling or wall.



Lubrication System Fact: New "4-way sealed", prelubricated bearing eliminates completely the 3 main causes of bearing failure: 1) contamination, 2) over greasing, 3) wrong grease.

NEW HEATING & COOLING EQUIPMENT



### Gas-Borne Solids Dry Fast

With the Parry dryer wet solids are dried uniformly and rapidly by turbulent gas. Already proved on wet coal, it works on other entrainable solids.

Conceived originally for drying coal, the Parry dryer removes surface, inherent or combined moisture from many materials that can be entrained pneumatically. It does the job rapidly and safely; is reliable, and economical to install, operate and maintain.

To remove moisture rapidly and efficiently requires high rates of heat transfer. The Parry dryer transfers heat rapidly by entraining particles turbulently in a stream of hot inert gas. Since the individual particles travel slower than the con-

veying media they are continually exposed to a rapidly changing atmosphere.

High rates of heat transfer permit the use of high-temperature drying gases without deleterious effects on the particles. Surface moisture is removed almost instantly, inherent moisture within seconds.

► High Throughput—A typical dryer adapted to coal, shown above, can dry 51 tons per hr. of coal from 35 to 4% moisture. Or with the furnace holding to the same 46 million Btu. per hr. heat release,

the unit will dry 93 tons per hr. from 20 to 4% moisture.

A dryer with this capacity would have a furnace 14 ft. in dia. and 35 ft. high; the dryer column would be 9 ft. in dia. and 17 ft. high.

Simpler Than It Looks—Design of the vertical down-fired furnace is simple and straightforward. Constructed of mild-steel, it is cylindrical and self supporting; is lined with rammed refractory backed by block insulation. Either fine coal, gas or oil can be burned in the burner mounted on top of the furnace.

A self-supporting large-diameter steel pipe comprises the dryer section. Located within the primary separator the dryer does not need to be insulated. There is a side opening fitted with a screw conveyor and abrasion-resistant refractory is used where the drying gases enter the chamber.

Built around the dryer column is the primary separator where the coarser solids drop out of the gas stream as velocity decreases. It is insulated externally and is equipped with a simple, star discharge valve.

High efficiency cyclones for separating the finer particles are mounted inside the primary separators. A separate hopper collects the fines, discharging through a star feeder into the primary air line to the furnace, when drying coal.

▶ Riding the Gas Stream—Wet solids, such as ½ x 0 in. coal, are fed into the dryer through the sideentering screw conveyor. The stream of hot, inert gas entrains the particles and carries them upward in very turbulent flow. As the stream rises, temperature decreases due to evaporation of the moisture.

Residence time of any particle in the dryer column is proportional to the square of the mean diameter of the particle. This corresponds approximately to the time required for heating the particle to remove the moisture. Or expressed another way, the larger the particle the longer it will be exposed to the drying atmosphere, insuring a uniformally dry product.

a new line — an old name

# LABOUR VALVES

Any old-timer—and most newcomers—in the chemical industry will tell you that LaBOUR means rugged dependability in chemical service. That reputation, earned over more than 30 years and the toughest jobs the process industries had, is too valuable to risk.





That's why you know you can depend on LaBOUR valves, recently introduced after the most critical testing in laboratory and field. Both globe and check valves are available—built for chemical service, not just made of corrosion resistant materials.

Ask for Bulletins H-1 and H-2.

ORIGINAL MANUFACTURERS OF THE SELF-PRIMING CENTRIFUGAL PUMP

LABOUR VALVES

THE LABOUR COMPANY, INC. \* ELKHART, INDIANA, U.S.A.



New Heating & Cooling Equipment	New Maintenance Tools & Supplies
Entrainment Dryer	Protective Coating
Steam and Hot Water Generator	Inspection Tool318B
Boiler Level Control	Valve Covers         318C           Insulation Covers         318D
New Instruments & Controls	
Process Analyzers	
Flowmeter Calibrator	New Electrical & Mechanical Equipment
Thickness Gage310C	Shaft Seal320A
	Electrical Assemblies320B
New Fluids Handling Equipment	Shaft Seal320C
Fabricated Valve	Improved Open Motors320D
Process Pumps	
High-Head Pump312C	No. Booksday & Woodling Postsmant
Stainless Pump	New Packaging & Handling Equipment
Expansion Joints	Transfer Tank
	Filling Machine
New Processing Equipment	Multiwall Bags
Ozone Generator	Cargo Container322D
Gas Purifiers	
Particle Separator	Equipment Cost Index
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For more details, use Reader Service Card

From the dryer column, the stream is directed into the primary separator then through the secondary separators. Part of the gas discharge is vented to atmosphere. The remainder is recycled to dilute the combustion gas, cooling it from 2,700 F. to 1,600 F.

Recycling exhaust-gas conserves heat and prevents hazardous accumulation of excess oxygen in the system. To maintain the inert atmosphere produced by recycling combustion products, the entire system is at a positive pressure.

▶ Control—Automatic controls assure producing a uniformly dry product. If feed rate or composition vary, the controls automatically regulate fuel and air to hold temperature constant in the exhaust gas from the dryer.—Silver Engineering Works, 3309 Blake St., Denver 5, Colo.

#### For More Information . .



about any item in this department, circle its code number on the Reader Service

Postcard inside the back cover.

#### **Combination Generator**

Can operate either as generator of hot water or steam. Quick changeover.

A new combination steam-hotwater generator provides hot water for basic process heating yet can convert to steam for cleaning and limited processing.

While the 60 hp. unit is essentially a hot-water generator a few simple adjustments convert it to steam operation within seconds. On either steam or hot water the generator operates completely automatically once the desired type of generation is selected.

As a hot-water generator operating on light oil, gas or a combination of these two fuels the Cyclotherm unit generates over 2 million Btu. per hr. It will deliver 2,480 gph. of hot water at 30 psi. with a 100 deg. temperature rise.

Delivery of steam is 2,070 lb. per hr. at 15 to 200 psi. Within five to ten minutes of changeover, unit can start delivering steam. Operator simply shuts off the main hot water inlet and outlet, drops the water level in the boiler and

switches the control panel from aquastat to pressuretrol control. Unit has dual control equipment.— Cyclotherm Div., U. S. Radiator Corp., Oswego 1, N. Y. 308A

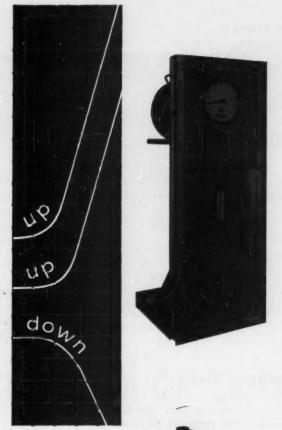
#### Level Control

For boilers up to 250 psi. is float-operated twin switch.

For use on boilers or other liquid level control jobs the new 92 Series control can: start and stop a boiler feed pump, interrupt current to burner if water drops to emergency level, or close alarm circuit.

Control features repulsion magnetic switching, permanent magnets are mounted with like poles facing each other. Other features include flat beryllium-copper springs to support the float arm and sufficient heat dissipation so that temperature at the wiring terminals does not exceed 167 F., the UL limit for 75 C wire.

Various modifications of the basic design permit satisfying all operating needs.—McDonnell & Miller, Inc., 3500 North Spaulding Ave., Chicago 18, Ill. 308B throughput quality costs



### process refractometer

(Type 38-201)

For monitoring or control of fractionating towers and streamblending operations. Automatic control can be established through completion of compositionactuated feedback loop...or information can be telemetered to pen recorders in the refinery control room. SEND FOR BULLETIN CEC 1839-X1.

Here are the first "Consolidated-Phillips" continuous process analyzers... units which provide analytical data while it's valid, before variables have changed. With these two instruments on stream, product quality and production go up... costs go down. You can install and maintain them for less, on an hourly basis, than a laboratory technician's salary. They need no elaborate facilities, can operate out-of-doors, are completely explosion-proof.

Consolidated-Phillips process analyzers have been proving their ability . . . and dependability . . . under actual plant conditions for several years. Originally designed and formerly manufactured by Phillips Petroleum Company, they are now backed by Consolidated Engineering's nationwide service organization . . . assurance of interruption-free operation for years to come.



Handles up to five streams at a rate of 5 analyses per hour per stream, i.e., 12-minute cycle period.

Increases fractionator capacity by holding product composition steady and minimizing operational fluctuations. Eliminates the time lag between sampling and laboratory batch analysis. SEND FOR BULLETIN CEC 1840-X1.

Whether your process instrumentation needs are for a single unit or a complete analysis-andcontrol system, you'll find it will pay to talk to a CEC Field Engineer. Write us today.

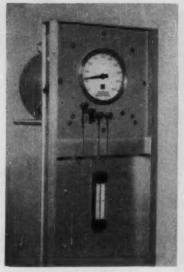
#### **Consolidated Engineering**

Corporation

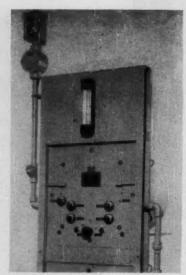
ELECTRONIC INSTRUMENTS
FOR MEASUREMENT AND CONTROL

300 North Sierra Madre Villa, Pasadena 15, California

Sales and Service Offices Located in: Albuquerque, Atlanta, Boston, Buffalo, Chicago,, Dallas, Detroit, New York, Pasadena, Philadelphia, San Francisco, Seattle, Washington, D.C.



Differential refractometer



Infrared analyzer

#### **New Analyzers Monitor Yield**

Four new plant analysis and control instruments for petroleum and petrochemical processing are to be marketed shortly by Consolidated Engineering Corp. Developed by Phillips Petroleum Co. the new devices can control fractionation, blending and synthesis automatically and continuously to improve product yield and quality.

Two of the instruments, the infrared analyzer and the refractometer, have already been ordered into production. Manufacture of the ultraviolet analyzer and oxygen analyzer is expected to begin within a few months.

In announcing the new line, Consolidated stressed design that is geared to plant operating needs. Designed for ambient temperatures up to 120 F. these instruments feature simple construction to give maximum trouble-free service. Systems are housed in steel bells that are explosion-proof in Class I, Group B locations.

▶ Infrared Analyzer—The infrared analyzer measures the concentration of a given component in streams of similar composition. It accommodates from one to five unknown samples plus a standard. A complete cycle requires an hour.

▶ Refractometer-Control of frac-

tionating tower operation is done with particular effectiveness by the differential refractometer. This instrument compares sample composition with that of a standard. Any variation from desired composition can be compensated automatically through a feedback loop.

Blending of two liquid streams also can be controlled by the differential refractometer.

Voltraviolet Analyzer—The ultraviolet analyzer or ultraviolet absorption spectrometer can be used, among other things, for analyzing one gas steam in a butadiene purification unit. A specially-designed light modulator between the light source and the sample cell changes the mean wavelength of radiation striking the photocell without affecting the over-all intensity very much. This type of modulator enhances the specificity of response for the instrument.

Poxygen Analyzer—The oxygen analyzer operates by measuring the change in color produced when liquid reagent reacts with oxygen. Range can be set to any oxygen value between 0-50 and 0-1,000 ppm. Analyzer output can be telemetered any reasonable distance.—Consolidated Engineering Corp., Pasadena, Calif. 310A

#### Flowmeter Calibrator

Precisely checks incremental weight and times of flow.

A new flowmeter calibration system utilizes a standard SR-4 load cell to give precise weight measurements within selected times.

A wide range of flow rates can be checked by measuring simultaneously incremental weights and time.

Instrument is a specially-designed indicator-controller. Electrical indications of weight from the load cell start and stop a timer automatically. The cell supports the tank that receives liquid passing through the flowmeter.

Empty-tank weight is zeroed out on the weight dial and any of five incremental weights is selected by turning a knob on the panel. After a specified quantity of liquid has passed through the meter the timer starts automatically. When the preset incremental weight has flowed through the meter the timer stops within 0.001 sec.—Baldwin-Lima-Hamilton Corp., Philadelphia 42, Pa. 310B

#### Thickness Gage

Measures a continuous running strip of material.

A recently announced Beta gage is designed to measure weight per unit area or thickness of a sheet or strip continuously without physical contact. It can be used on plastics, rubber, textiles and paper.

Instrument operates by emitting beta rays from radio-active isotopes. Variation in absorption by the sheet material gives a measure of weight or thickness changes.

Instrument has an amplifier cabinet with recorder, a control unit, and a detector head and radiation source. A tolerance indicator actuates a visible or audible warning if predetermined limits are exceeded.

Controls can be set to report only a defect that persists beyond a specified period of time, or a sum of deviations within a given interval. — Curtiss-Wright Corp., Woodridge, N. J. 310C



# FIND OUT-How Many Ways This Cooler Can Cut Costs for You!

SAVE ON INSTALLATION You save up to 30%

on installation costs

over comparable coolers. Pre-tested and pre-assembled, your cooler is shipped to your site in two sections where it is easily installed without costly revamping of plant. Less headroom is required — there are fewer costly auxiliaries.

Movable baffle in air housing above SAVE ON FUEL clinker bed isolates and directs hottest air to kiln. Combustion efficiency is greatly increased.

Uniform bed of material passing SAVE ON POWER over grating requires only low pressure air. Comparatively smaller fan and motor uses only about 1/2 hp-hr per barrel of clinker. Fewer auxiliaries to drive.

Simplified design and SAVE ON MAINTENANCE small number of parts require little attention. Low upkeep cost. Lubrication is required only on drive mechanism. Only four grease fittings. Horizontal grate system insures smooth flowing bed of material and high efficiency cooling throughout. There is little or no wear on grates or grate warpage. Maintenance is only about 1/10 cent per barrel of clinker.

### SEND FOR NEW HANDBOOK ON **Air-Quenching Coolers**

Contains valuable engineering information on cooling that can help make your operations more profitable! It's a book

you'll want to have and

ALLIS-CHALMERS Milwaukee 1, Wis.

Please send my copy of Air-Quenching Cooler Bulletin 07B7869.

Company

Position

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**ALLIS-CHALME** 





#### Valve

For 150-lb. service is lightweight, quick-acting and seatless.

Featuring lightweight, fabricated construction the New Hemco valve provides full flow with minimum pressure drop, turbulence and aeration. It is claimed to include and improve upon the ruggedness and simplicity of the gate valve, cleanliness of the plug valve and the flow characteristics of the gate valve.

Valve has a rising and falling plug that terminates in an O-ring sock. Except when the plug is rotated to raise it, upstream pressure scals the plug against the walls of the flow channel where it changes direction. An O-ring on the upper part of the plug in the stem section prevents leakage out of the system.

Valve can be furnished for threaded, flanged, or welded connections. There is a wide choice of body metals and O-ring compounds to satisfy most process needs.— The Hurt Corp., 997 South Marengo, Pasadena, Calif. 312A

#### **Process Pumps**

Built to handle the most severe pumping duty.

A completely new line of heavyduty chemical process pumps features simple, sturdy and versatile construction. This series H line is built for high heads and low capacities as well as for routine transfer services.

A large shaft and heavy bearings allow only minimum shaft deflection. Suction and discharge are integral with the casing. When a spacer coupling is used, the entire pump, except the casing, can be removed from the line without disturbing the piping.

Minimum parts inventory results from the flexibility of the adaptor and the bearing housing. Each adaptor accommodates several pump sizes. The entire range of sizes requires just three bearing housings.

Series H pumps are available in standard Durco corrosion-resisting alloys including Durimet 20, Chlorimet 2, Chlorimet 3, and in stainless and other materials.—The Duriron Co., Inc., Dayton 1, Ohio. 312B

#### High-Head Pump

Guaranteed not to leak at heads up to 150 ft.

The latest addition to the Chempump line of canned-rotor pumps is a 1½-hp. unit guaranteed to pump up to 53 gpm. at 150 ft. head without leaking. This standard model CFH unit handles corrosive, explosive and similar difficult fluids at temperatures up to 450 F. and pressures to 300 psi.

Chempump seal-less centrifugals have pump and motor combined within a single compact unit. Fluid handled circulates through the rotor chamber of the motor to cool it and lubricate the bearings.

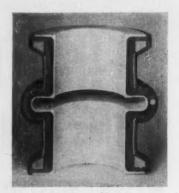
The CFH series is built in cast iron, 316 stainless steel, monel or Carpenter-20.—Chempump Corp., Station D, 1300 East Mermaid Lane, Philadelphia 18, Pa. 312C

#### **Stainless Pump**

Fitted with Teflon-ceramic seal that resists corrosion and abrasion.

Adoption of a new Teflonceramic seal has greatly broadened application of the Eco pump on corrosive liquids and slurries. On a recent test diatomaceous earth slurry was handled continuously for more than 20 weeks without damaging the seal, although much of the impeller was worn away. New gland is dimensionally identical and interchangeable with the stellite-graphitized carbon seal used on the standard-model pump. Proximity to the suction port keeps the gland under reduced pressure and effectively keeps foreign matter from working into the seal.

It is recommended that seal be operated below 160 F. Higher temperatures can be tolerated briefly on intermittent service. — Eco Engineering Co., 12 New York Ave., Newark 1, N. J. 312D



#### **Expansion Joints**

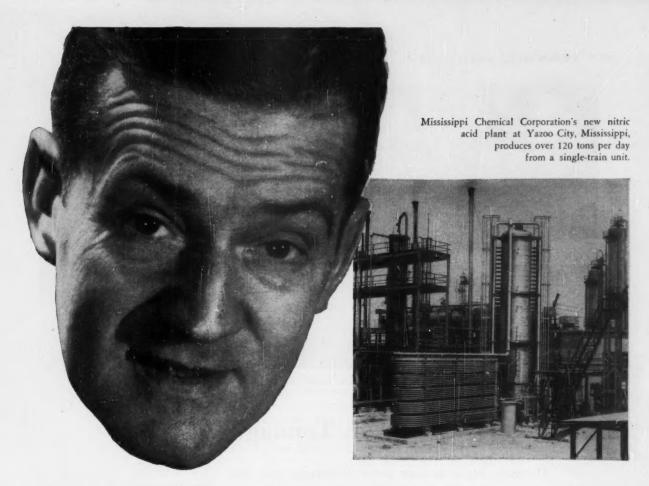
Designed for use with trademarked piping fabricated of special material.

Rubber expansion joints just announced are designed for use with piping and flanges made by the Haveg Corp. and The Duriron Co.

These joints are made of a highgrade rubber compound combined with plies of sturdy cotton duck and reinforced with steel wire. Steel rings in the flange ends of the joint permit tightening of the connections without shearing the expansion joint.

Where oil may be present in the line a neoprene lining is furnished. If the outside of the joint also is in contact with oil a neoprene cover is added. Neoprene construction is used throughout if the line carries petroleum derivatives. On service harmful to rubbers a Teflon liner is used.

Identified as 209 expansion joints these units are furnished for pipe sizes from 1 to 12 in. inclusive.—The Garlock Packing Co., Palmyra, N. Y. 312E



"...now you can have greater nitric acid production with lower initial investment"

This new plant, incorporating C & I's new design, costs far less and is more compact than any nitric acid plant of similar capacity in the world. The plant has one absorption column, one converter and a centrifugal compressor with expander turbine. Its rated capacity is 120 TONS PER DAY; however, it is producing in excess of this figure without noticeable decrease in efficiency. The plant recovers more than one half of its necessary operating energy by utilizing tail-gas energy, thus greatly reducing operating costs.

If you are considering nitric acid production or expanding your present facilities, it will pay you to consult C & I. For only C & I can supply single-train plants capable of producing nitric acid at 120, 180, 200 and 250 tons per day.

C & I also designs and builds Complex Fertilizer Plants, Ammonium Nitrate Solutions and Solids Plants (Stengel Process), and Ammonium Nitrate Ammonia Solutions Plants.

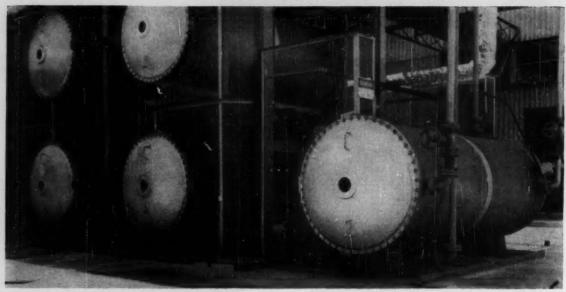
Specialists in



Processing Ammonia

THE CHEMICAL AND INDUSTRIAL CORP.

CINCINNATI 26, OHIO



GROUPED together, individual generators pour stream of ozone into process that calls for . . .

### Generating Ozone on Tonnage Basis

If ozone fits into your process picture, you can generate your own safely and reliably with proved ozonators. They work on either air or oxygen feed.

Ozone for oxidation now can be produced commercially with outputs ranging from 0.1 to 10,000 lb. or more per day. Model G-204 ozonator, using air feed produces 60 lb. of ozone per day, or 120 lb. per day using oxygen feed. Multiples of this unit are operating in tonnage ozone plants now.

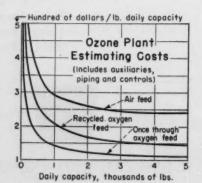
Air discharges from the ozonator containing approximately 1% by weight ozone. With oxygen feed the ozone concentration is doubled. Durable and Safe—There are no moving parts in the ozonator. Units will operate continuously with a life expectancy of at least 25 years. Only yearly cleaning is required.

Ozonators are safeguarded completely to confine the ozone and eliminate electrical hazards. High voltage parts are surrounded by grounded metal enclosures. Access openings are interlocked electrically or mechanically to prohibit entrance without prior isolation of the electrical circuits involved.

Simple Construction—Commercial ozone generators are constructed with stainless-steel tubes fastened into a stainless-steel shell which serves as a cooling-water jacket. A special glass dielectric fits concentrically within each tube.

The standard glass dielectric tube has electrically-conductive coating on the internal surface. Tube diameter is approximately 3 in.; each dielectric is centered precisely.

In the annulus between the out-



side of the glass tube and the inner surface of the stainless-steel tube an electric discharge takes place. Oxygen passing through the annular space is partially converted into ozone by the discharge.

▶ Power Needs—A 15,000-v. potential impressed across two sets of electrodes causes current to flow across the annulus in the form of a diffuse discharge. One set of electrodes is the stainless-steel tubes; the other is the electrically-conductive coatings on the dielectric.

To generate 1 lb. of ozone from dry air at approximately 1% concentration requires 8-9 kwh. If dry oxygen is used approximately 2% concentration is obtained and only 4-4½ kwh. of electrical energy are consumed for each pound of ozone produced.

► Auxiliaries—In order to operate an ozonator, a source of dry air or oxygen is needed.

For plants using air, an air filter, compressor, cooler and dryer are required. Depending upon the size of the ozone unit, the air filter may be a cartridge unit with replaceable element, or in larger plants, an electrostatic precipitator. The blow-

# SIAN DIESEI

engine lubricant
developed specifically
to meet problems posed
by new engine designs,
higher loads, economy fuels

New Stanodiesel Oil M meets—
and with plenty to spare—the performance
requirements imposed on diesel lubricants
by new engine designs, higher loads and the use of
economy fuels. It meets these requirements because,
first of all, it is an oil refined from the finest quality base
stocks. It thus has superior stability. Then additives
exclusive with Stanodiesel Oil M have been blended with
these base stocks. The additives do these things:

- INHIBIT OXIDATION. Prevent unwanted increases in oil viscosity. Prevent corrosion of bearings.
- PROVIDE DETERGENT-DISPERSANT ACTION.

  Keep crankcase, pistons, cylinder walls and other parts clean. Keep contaminants in suspension, prevent redeposit.
- PROVIDE ANTI-FOAM ACTION. Foaming tendencies of oil are controlled. Oil is suitable for use in hydraulic governors.
- 4 oil's ability to reach and maintain a film on highly stressed parts.

STANODIESEL Oil M is a "Mil" type oil.

Your next move? Find out how STANODIESEL Oil M can serve you. In the Midwest call your nearby Standard Oil lubrication specialist. Or contact Standard Oil Company, 910 South Michigan Avenue, Chicago 80, Illinois.

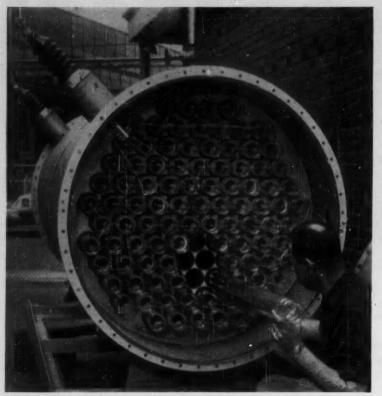
#### STANODIESEL OIL M

Does these things for your engine

- I Lessens engine deposits, ring and cylinder wear.
- 2 Lessens spark plug fouling.
- 3 Lessens fuel injector and pump sticking resulting from engine deposits.



TANDANG CHE COMPANY (Indiana)



DIELECTRIC can be removed easily from ozonator for check or repair.

er is a rotary, positive displacement type, non-internally lubricated.

After filtering, the air must be cooled and dried. Cooling precipitates part of the moisture from the air thus reducing the size of dryer necessary. A dryness corresponding to a frost point (dew point) not greater than minus 60 F. is recommended. Higher frost points will reduce output and efficiency and increase maintenance.

Such dryness is obtained with absorptive type, dual-tower dryers for continuous operation. Either silica gel or activated alumina serves as a dessicant.

Where plants are to be operated on oxygen, the auxiliary requirements depend upon the quality and source of the oxygen. Oxygen drawn from a liquefaction distillation column at 8-10 psi. will be sufficiently dry to be used directly.

However, since economic considerations usually demand recovery and recycle of oxygen, a blower, cooler and desiccant-type dryer also will be required. In addition, other auxiliary units may be necessary to remove impurities picked up by the oxygen in process. The impurities themselves and the method of removal usually must be determined by an actual pilot plant test.

Electrolytic oxygen, as such, is not suitable for use in an ozonator because small quantities of hydrogen are present as an impurity. However, by a new process (patent pending) even trace amounts of hydrogen can be removed to make electrolytic oxygen suitable.—The Welsbach Corp., 1500 Walnut St., Philadelphia 2, Pa. 314A

For More Information . .



about any item in this department, circle its code number on the Reader Service

Postcard inside the back cover.

#### **Gas Purifiers**

For production of ammonia synthesis gas from coke-oven gas.

An exclusive agreement recently completed makes available through Air Products, Inc. all the Dutch State Mines know-how for production of ammonia synthesis gas from coke-oven gas. Air Products now offers the equipment needed for purification of the coke-oven gas before synthesis of ammonia.

Design and manufacture of equipment for low-temperature separation of coke-oven gas will be based entirely upon American chemical engineering practice. However, the equipment will incorporate all the process design and operating experience developed by Dutch State Mines during the 25 years they have been engaged in the business.

—Air Products, Inc., Allentown, Pa. 316A

#### **Partiele Separator**

Claims close size separations by pneumatic method.

For classification of fine sieve and sub-sieve sizes the new Air Screen is said to offer clean-cut separations. It is particularly effective removing a small quantity of fine particles from coarse material. Unit can be operated either continuously or batchwise.

Granular material is fed by gravity to a low point in the center of the equipment where a suction nozzle picks it up. It is carried upward by an expanding air stream, along deflectors and past material-diverting passages.

Flow is controlled to permit particles larger than the desired cut to settle out for discharge through a side outlet. Particles smaller than the desired cut are carried out with the air stream.

Unit can be operated as either a suction or pressure system. Size is governed largely by the proportion of fines in the feed.—Airborne Conveyors Corp., 99 Hudson St., New York 13, N. Y. 316B



# THE HEAT'S ON ... and fast!

YARWAY Impulse Steam Traps get equipment hot in a hurry, and keep it hot.

As soon as steam is turned on—SNAP—the little stainless steel valve opens wide, discharges condensate and air continuously until steam arrives. Then—SNAP—the valve shuts. Equipment reaches operating temperature in the shortest possible time.

After that the little valve actually floats on the condensate load—maintains peak temperatures.

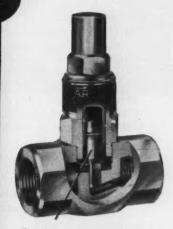
Other Yarway features:

- Stainless steel-body and internal parts.
- Good for all pressures without change of valve or seat.
- Low maintenance—one moving part.
- Easy installation—small size, light weight.
- Non-freezing at low temperatures.
- Six standard sizes, 1/2" to 2".

Want proof of performance? Try a YARWAY Impulse Trap and Fine Screen Strainer FREE for 90 days in your own plant. For free trial, or free catalog, write...

#### YARNALL-WARING COMPANY

137 Mermaid Ave., Philadelphia 18, Pa.



This little valve—only moving part in a YARWAY Impulse Steam Trap—floats on the condensate load. It gets equipment hot in a hurry and keeps it hot!

impulse steam trap

OVER 1,000,000 YARWAY IMPULSE TRAPS SOLD - STOCKED BY 270 CONVENIENT INDUSTRIAL DISTRIBUTORS

CHEMICAL ENGINEERING—June 1955

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#### **Protective Coating**

Applied to concrete to avoid fluorine attack.

Concrete can be protected from the inroads of fluorides, hydrofluoric acid and hydrofluoric acid solutions by applying a 1-in. layer of Ceilcrete "B." It's a thermosetting plastic-base surfacing with high density and stonelike hardness. Combined with acid resistance it withstands impact and abrasion.

In many applications Ceilcrete "B" actually has replaced brick. While proving completely satisfactory as a replacement it has also reduced cost substantially.—The Ceilcote Co., 4836 Ridge Rd., Cleveland, Ohio. 318A

#### **Inspection Tool**

Locates surface or sub-surface flaws in steel equipment.

Plant maintenance inspections can be more effective through use of the SempuN magnetic flaw detector. It is a permanent magnet with unique ball pivots and multiself-adjusting magnetic pins that provide good contact on any surface contour.

Due to the nature of the device equipment can be inspected in hazardous areas without danger of fire. Since the permanent magnet supplies d.c. magnetic force, sub-surface as well as surface flaws are detected. Detector is supplied complete with check test piece, remagnetizing leads and plastic spray bottles containing the iron oxide powder or ink inspection mediums. Need for remagnetization is determined by inspecting the check test piece for its known flaws. Magnet is reenergized by connecting the leads across a 6 or 12-v. battery.—Rice-Peterson Sales, Inc., P. O. Box 1114, Palo Alto, Calif. 318B

#### Valve Covers

Made of Dynel protect workers against leakage.

Dynel covers for valves and flanges are claimed superior to heavy-metal covers both in initial cost and upkeep. Also, these acidand caustic-resistant covers are said to be easier to install and store. For More Information ...

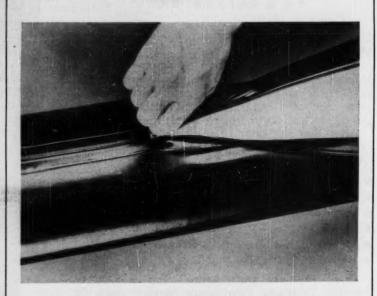


about any item in this department, circle its code number on the Reader Service

Postcard inside the back cover.

Dynel covers conform with the contour of valve connections. Repair work is easier; the covers can be unwrapped from the installation, laundered and reused. They are sufficiently strong to contain sprays from failure of gasket or packing on pressurized lines yet permit complete operating freedom of covered valves.

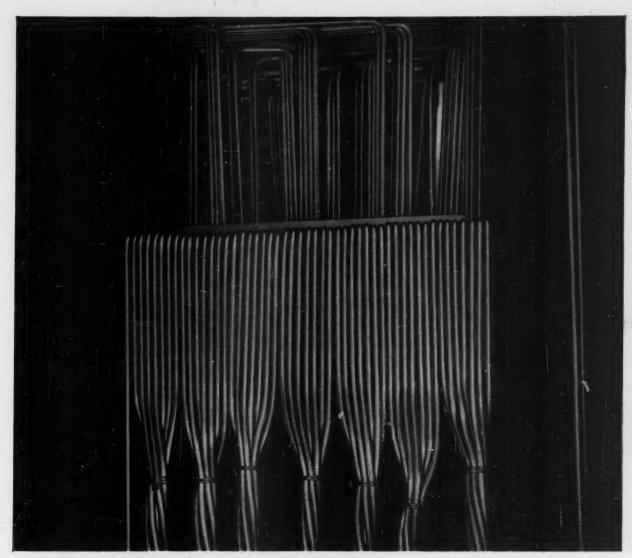
ChemKovers are available in a wide range of sizes at prices ranging from 70¢ to \$5.—Mine Safety Appliances Co., Braddock, Thomas & Meade St., Pittsburgh 8, Pa. 318C



#### Removable Plastic Cover Protects Insulation

Just pull the slide fastener and you can install or remove this preformed-plastic insulation cover in a jiffy. End joints or fittings are wrapped tightly with plastic tape then sealed with a vinyl-resin coating. Protekinsul is flexible, durable and highly

resistant to moisture-vapor transmission, mold, mildew and most chemicals. Available in black or colors in lengths up to 100 ft. to cover insulated pipe from ½ to 33 in. dia.—Miracle Adhesives Corp., 214 East 53rd St., New York 22, N. Y. 318D



Cabled copper instrument tubing installed at Appalachian Electric Power Company's Kanawha River Station. You see it at the point where the cable divides for run-outs to instruments. Note smooth, short-radius bends.

### 108,000 feet of cabled copper instrument-control tubing helps keep Kanawha River Power Station humming

Hundreds of air-actuated instruments are an important part of the instrumentation control network at the 430,000-kw Kanawha River Station of the Appalachian Electric Power Company — part of the American Gas and Electric System. The size of the plant called for instrument tubing runs of up to 1,000 feet — with tubing cabled in bundles. For economical stranding, the tubing was needed in unusual lengths — without joints. To conserve space, small diameter tubing was needed. And ability to take short-radius bends without pinching was necessary.

The 108,000 feet of Anaconda Seamless Copper Tubing was supplied in 1,000-feet lengths. Outside diameter was only ¼-inch, wall thickness only .030". Shown above are typical tube bundles

as they near terminal connections.

Anaconda small-bore, thin-wall tubing is available in lengths up to 2,400 feet. It comes in long coils on reels, or cut to your requirements. Capillary tubes, restrictor tubes, Bourdon tubes, special shapes, and fabricated tubes and parts for refrigeration and air-conditioning are available in many different alloys. These include phosphorized and OFHC copper, the full range of brasses, 3,003 aluminum, nickel silvers, and certain special alloys. For more information about Anaconda small-bore tubes and special shapes ask any district sales office, or write direct to The American Brass Company, Waterbury 20, Connecticut. In Canada: Anaconda American Brass Ltd., New Toronto, Ontario.

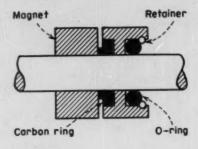


Some of the many sizes and shapes of Anaconda Small-diameter Tubes.

ANACONDA®

SMALL DIAMETER TUBES

#### NEW ELECTRICAL & MECHANICAL EQUIPMENT



#### Shaft Seal

Uses magnet to hold sealing surfaces together.

Longer life, lower cost and greater efficiency are claimed for a new rotary seal that prevents escape of fluids under pressure around a rotating shaft. Seal uses magnetic force rather than bulky springs to keep sealing surfaces in effective contact when no fluid pressure exists.

Seal has a sealing surface on permanently-magnetized ring which is secured to the housing. A second ring, coupled to the shaft by an O-ring, has a carbon-ring sealing member. Magnetic attraction brings the sealing surfaces of the two rings together. Pressure is distributed equally on the seal to maintain proper alignment of the faces.

Seal is effective under pressures up to 3,000 psi. and temperatures to 500 F.—Magnetic Seal Corp., Higgins St., Georgiaville, R. I.

320A

#### Electrical Assemblies

Now factory fabricated for better electrical circuits.

Jumpers, leads and lug assemblies are being factory fabricated for improved electrical performance. They are custom made to meet exacting specifications.

Connections using these assemblies have current-carrying capacity equal to the conductors. Power loss from deteriorating connections is eliminated.

Prefabricated assemblies can be installed at less cost. They do not corrode, therefore, require no repair or inspection.—Erico Products, Inc., 2070 East 61st Place, Cleveland 3, Ohio. 320B

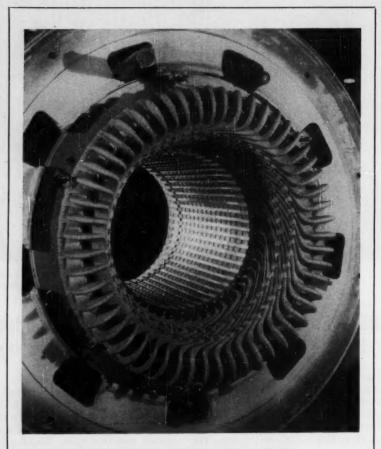
#### Shaft Seal

For side-entering mixers makes repairs or replacement possible under full tank pressure.

A new mechanical shaft seal for side-entering mixers eliminates need for costly tank drainage when maintenance is needed. Also it prevents loss of product in case of seal failure.

A secondary seal incorporated in the unit seals off the tank while the mechanical seal is being serviced. Thus, without inconvenience the mechanical seal can be repaired, replaced or converted to a conventional stuffing box if replacement parts are not immediately available on location.

The Sealol-Flexibox mechanical shaft seal can be repaired easily in the field at very low cost. The two vital seal elements, a graphite ring and mating ring, can be replaced without disturbing the rest of the seal.—New England Tank & Tower Co., Everett, Mass. 320C

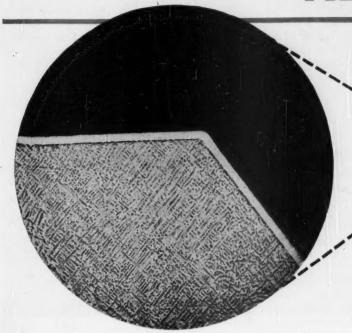


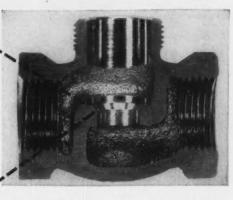
#### New Insulation Extends Open-Motor Usage

First all-silicone-rubber insulation system for large motors and generators will protect this stator for a 2,500 hp., 2,300-v., 3,580-rpm. induction motor under extreme moisture conditions. Compounded of pure silicon-gum rubber and silicon dioxide, Silco-Flex insulation is expected to permit wider use of semi-

protected and open-type motor frames in the chemical and process industries. Now available on large equipment Silco-Flex insulation combines outstanding thermal endurance and moisture resistance with flexibility and resilience similar to organic rubber. — Allis-Chalmers Mfg. Co., Milwaukee 1, Wis. 320D

# Plate Any Surface—with ALCOPLATE\*





This ½-in. valve body (actual size) was Alcoplated by immersion and sectioned to show thorough deposition of plate—even on interior valve seats. Photomicrograph (left) of valve seat illustrates Alcoplate's minute coverage of metal irregularities, evenness of plate deposit. Your Alco salesman will be happy to show you one of these valve bodies, and he will supply you with Alcoplate samples for your own tests.

## Complicated surfaces — impossible to electroplate or to clad — are corrosion-protected with ALCOPLATE

Almost any base metal—any shape—can be thoroughly plated with protective nickel by the Alcoplate process. Alcoplate, an electroless liquid-chemical plating method, bonds a uniform nickel coating to any surface. Coverage is complete and plate thickness, in normal assignments, is within 0.0003 in. of specification (0.003-in. thickness varies from 0.0027 to 0.0033 in.). Even on pieces impossible to electroplate there are no hard-to-reach areas, no costly overplating. And Alcoplate gives the plated material better corrosion resistance than electroplate. In fact, it equals or betters the corrosion resistance of pure or wrought nickel.

Here are some other advantages of ALCOPLATE:

- Better composition than electroplate—ALCOPLATE is harder, has almost zero porosity at minimum thickness. In some services where electroplate has failed because of porosity, ALCOPLATE is not affected.
- Excellent plate adhesion—ALCOPLATED steel specimens pulled to the yield point show no signs of flaking or spalling.
- High abrasion resistance—Hardness is 48 Rockwell C and can be increased to 66 Rockwell C through post-plate heat treatment.

ALCO invites your thorough investigation: Write ALCO, Box 1065, Schenectady, New York, for a copy of the new product bulletin on ALCOPLATE

ALCO

### ALCO PRODUCTS, INC.

formerly AMERICAN LOCOMOTIVE COMPANY

#### Consult your ALCO Sales and Engineering Representative at:

BEAUMONT, TEX. CHICAGO, ILL. CLEVELAND, OHIO HOUSTON, TEX. KANSAS CITY, MO. LOS ANGELES, CALIF. NEW YORK, N. Y. PITTSBURGH, PA.
ST. LOUIS, MO.
ST. PAUL, MINN.
SAN FRANCISCO, CALIF.
TULSA, OKLA.
WASHINGTON, D. C.

\*ALCOPLATE—Trade-mark registration applied for. An application of "Kanigen," a mark identifying the chemical deposition of high-nickel, low-phoephorous alloy by General American Transportation Corporation and its licensees and the coating resulting therefrom—on license from the General American Transportation Corporation.



#### Transfer Tank

Serves as pipeline on wheels.

A new portable storage-transfer tank offers an efficient, economical substitute for expensive pipe-valve-pump systems. It is particularly adaptable where there are varying and intermittent requirements for heavy acids or industrial chemicals in different plant areas.

As transfer tanks these units eliminate dangerous and cumbersome handling of carboys. Also they can serve as temporary storage tanks during repair or cleanout of permanent storage equipment.

Tanks are available with a variety of sheet linings or coatings for complete protection against a wide range of corrosive materials. Designs cover capacities from 200 gal. upward mounted on either skids or casters. — Heil Process Equipment Corp., 12901 Elmwood, Cleveland 11, Ohio 322A

#### Filling Machine

Fills open-mouth multiwall shipping sacks, is economical to install and maintain.

An automatic filling machine for open-mouth multiwall bags combines high speed and accuracy with low installation and maintenance cost. Although functioning like other machines of this type it has exclusive controls to maintain unusual accuracy at high speeds.

Machine can handle all weights from 25 to 200 lb., with an average variance of not more than 8 oz. plus or minus under ordinary production conditions during a full day's operation. No head of mate-

rial is needed by the machine to hold this accuracy.

With one man hanging bags the charging rate is 22 to 24 100-lb. bags per min. This rate is said to save packaging costs.—Kraft Bag Corp., 630 Fifth Ave., New York 20, N. Y. 322B

#### **Multiwall Bags**

Now designed for smooth, easy opening.

A new snap-open design makes industrial multiwall bags easier to use. It is said to reduce opening time and eliminate spillage from ragged openings that waste material. No longer is there need for knife, scissors, shovel or other device.

The quick-opening device consists of a series of small perforations in one corner of the bag under the tape and near the sewing line. By grasping the tape at this corner and pulling sharply upward, an opening

is started instantly. It can be stopped at any point convenient for controlled spout pouring, or continued along the entire length.

—Hudson Pulp & Paper Corp., 477 Madison Ave., New York, N. Y.

322C

#### **Equipment Cost Indexes**

	Dec. 1954	March 1955
Industry Avg. of all	184.2	186.2
Process Industries		
Cement mfg	177.1	178.4
Chemical	185.7	187.1
Clay products	171.9	173.2
Glass mfg	175.5	176.8
Paint mfg	178.8	180.1
Paper mfg	179.1	180.4
Petroleum ind	182.3	183.7
Rubber ind	184.7	186.1
Process ind. avg	182.8	184.2
Related Industries		
Elec. power equip	187.5	188.9
Mining, milling	186.6	188.0
Refrigerating	204.1	206.8
Steam power	175.0	176.3

Compiled quarterly by Marshall and Stevens, Inc. of III., Chicago, for 47 different industries. See Chem. Eng., Nov. 1947, pp. 124-6 for method of obtaining index numbers; March 1955, pp. 178-9 for annual averages since 1913.



#### For Modern Freight, Giant Unit Load

In a new attack on shipping and handling costs Clark Equipment Co. has evolved this Mobilvan mobile warehouse. It takes advantage of and smoothly combines the most economical aspects of trucking and railroad transportation — provides storage as well. Fitting three to a railroad flatcar, two to a conventional highway trailer or one to a city delivery truck they can be transferred either by a fork-lift truck or a straddle carrier.—Clark Equipment Co., Battle Creek, Mich. 322D



On a 10¢-per-gallon product, 6 CC of leakage per minute costs you about \$90 per year in unnecessary product waste.

REPLACE
PUMP PACKING WITH

# BJ mechanical seals

Eliminate unnecessary stuffingbox leakage by installing a BJ Mechanical Seal. You not only realize important savings of pumped products but you also save on repacking and downtime losses. A BJ Mechanical Seal also prevents contamination of the pumped liquid ... protects against volatile and corrosive liquid hazards.



# BJ MAKES A COMPLETE LINE OF MECHANICAL SEALS...

BJ makes reliable high-precision seals in material and construction combinations to answer almost any pressure, temperature and liquid requirements. This means that BJ can provide the one best seal for each specific pumping need, Ask your nearest BJ sales engineer to show you how Mechanical Seals can save you money. Or you can obtain further information by writing for BJ Bulletin No. 54-1-10,000.

BJ SINCE 1872

# Byron Jackson Co.

P. O. BOX 2017 TERMINAL ANNEX • LOS ANGELES 54, CALIF. Sales Offices in Principal Cities

CHEMICAL ENGINEERING—June 1955

# Practical service training at Honeywell's school . . .

makes your instrument men more valuable

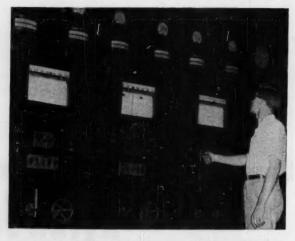
Your instrument maintenance men can get a real education in the most up-to-date methods for servicing instruments, at Honeywell's Training School. Any organization which uses Honeywell instruments can send maintenance personnel to this school. Tuition costs you nothing, for this school is maintained as a "plus-value" service to Honeywell customers.

Thousands of technicians have either started or augmented their instrument knowledge here. A variety of courses is available, to fit men for the particular kind of maintenance problems they may encounter in their specific jobs. The comprehensive course . . . one of the most complete and intensive offered anywhere . . . covers about thirteen weeks. Other courses cover five weeks and less, to offer condensed instruction of either a basic or "refresher" nature to men who can't be spared for extended periods.

There's nothing academic about this school. The emphasis is placed on practical knowledge. Theory through lectures and textbook study is liberally supplemented by laboratory sessions and actual bench work on all types of instruments and related equipment.

One caution: classes have to be limited to assure thorough attention to all students, so make reservations in advance. Your local Honeywell office will be glad to make arrangements. Call today . . . it's as near as your phone.

# Coordinated control helps reduce cost of



Ammonia synthesis converters are controlled from this panel, on which are multi-point ElectroniK temperature recorders and (near top) Pyr-O-Vane millivoltmeter indicators.



# high pressure ammonia plant

THE Claude process ammonia synthesis plant of Mississippi Chemical Corporation, at Yazoo City, Miss., was built at a substantial saving in initial cost . . . through the elimination of intermediate storage and surge tanks. Raw materials go through the process in a continuous stream.

To achieve this, every phase of processing must be held in precise coordination. Thorough, automatic control is the answer. Furthermore, the control system has to do its job accurately and unfailingly, for any deviations from desired conditions would be magnified throughout the process. To achieve these objectives, Brown recorders and controllers were selected for many assignments.

The variety of applications demonstrates the broad scope which this line of instrumentation covers... including temperature, pressure, flow, liquid level, gas composition. On the critical high pressure synthesis reaction, for example, a multi-point *ElectroniK* instrument records six selected temperatures. In addition, Brown millivoltmeter pyrometers provide

continuous indication of each, to guide operators during start-up and emergencies. Purge gas pressure and flow are recorded on two-pen instruments. Similarly, the carbon monoxide converters, carbon dioxide absorbers and other units are fully equipped with essential measurement and control systems.

By turning to a single source of control instrumentation for so many varied types of systems, any plant can enjoy the advantages of unified responsibility . . . simplified training of operating and maintenance personnel . . . and assurance of coordinated engineering of equipment that must function harmoniously for maximum overall efficiency.

Ask your local Honeywell sales engineer to discuss ways that your own process control requirements can profit by this broad line of instrumentation. Call him today . . . he's as near as your phone.

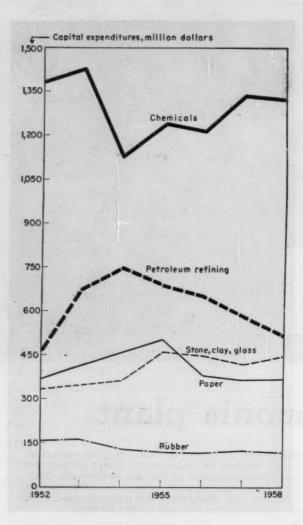
MINNEAPOLIS-HONEYWELL REGULATOR Co., Industrial Division, Wayne and Windrim Avenues, Philadelphia 44, Pa.—in Canada, Toronto 17, Ontario.

• REFERENCE DATA: Write for Composite Catalog No. 5002 for a condensed description of the complete Honeywell line.



Honeywell BROWN INSTRUMENTS

First in Controls



## **Spending Spree Looms**

Though capital expenditures dipped last year, they're on the rise now. And there's every indication that they'll keep going up at least through 1958.

#### William H. Chartener, McGraw-Hill Dept. of Economics

Chemical processing companies plan to put 7% more into capital expenditures in 1955 than they did last year, according to the eighth annual survey of Business' Plans for New Plants and Equipment just completed by McGraw-Hill. Manufacturing firms as a whole plan a 3% boost in capital outlay this year. For all business the planned increase is 5%.

Stone, clay and glass top the chemical processing group in percentage rise-up 28%. Makers of chemicals and paper plan increases of 10% in 1955. Rubber producers and petroleum refiners, on the other hand, expect to decrease their capital spending by 7% and 8%, respectively.

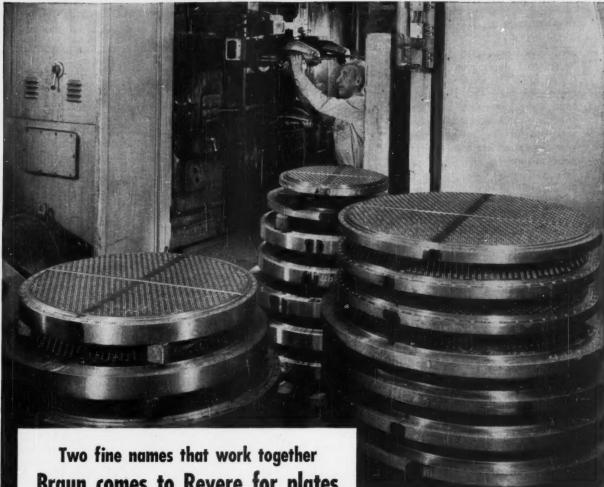
► Even Better Years Ahead—The rising trend in capital spending, halted briefly in 1954, looks like it will carry far beyond 1955. Preliminary plans of all business for expenditures in 1956 are only 3% lower than plans for 1955; for manufacturing alone they are 7% below this year's plans.

In the past these preliminary plans have always

U. S. Business Capital Expenditures-Actual and Planned-Millions of Dollars

	1952	1953	1954* Actual	1955 Planned	1954-55 % Change	1956	1957 —Preliminary—	1958
Primary metals	\$1,776	\$1,385	\$811	\$1,049	+28	\$1,142	\$899	\$937
Metalworking	2,737	3,066	3,249	3,145	- 3	2,727	2,579	2,497
Chemical processing	2.704	3,019	2,827	3,017	+ 7	2,821	2,825	2,775
Chemicals	1,386	1,428	1,130	1,243	+10	1,218	1,330	1,318
Paper	364	409	455	501	+10	381	366	371
Rubber	154	161	131	122	- 7	118	124	121
Stone, clay, glass	330	346	361	461	+28	448	418	447
Petroleum refining1	470	675	750	690	- 8	656	587	518
Foods and beverages	769	812	765	712	- 7	606	672	631
Textiles	434	378	331	349	+ 5	303	320	320
Miscellaneous manufacturing	900	1,018	932	961	+ 3	962	949	877
ALL MANUFACTURING	9,320	9,678	8,915	9,226	+ 3	8,561	8,237	8,037
Petroleum Industry <sup>1</sup>	4,100	4,600	4,900	4,913	0	4,961	4,921	4,920
Mining	567	546	396	387	- 2	298	237	251
Railroads	1,396	1,311	854	820	- 4	812	795	754
Other transportation, communication	2,844	3,030	2,975	2,969	0	3,082	3,026	2,743
Electric and gas utilities?	3,887	4,552	4,219	4,430	+ 5	3,766	3.544	3.987
Commercial	5,445	6,180	6,379	7,336	+15	7,536	7,629	6,969
ALL BUSINESS	27,089	29,222	27,888	29,391	+ 5	28,380	27,802	27,143

<sup>&</sup>lt;sup>1</sup> Petroleum refining, included in both manufecturing and petroleum industry, is counted only once in tota <sup>2</sup> Electrical World, American Gas Association for 1955-58. \* Dept. of Commerce, SEC, McGraw-Hill.



Tube sheets at 4-spindle automatic drill in Braun shop.

Braun comes to Revere for plates
C. F. Braun & Co., Alhambra, Calif. is well known in the

C. F. Braun & Co., Alhambra, Calif. is well known in the petroleum industry, the chemical industry, and other businesses in which heat transfer and fractionation are vital. Revere Copper and Brass Incorporated is well known in the non-ferrous metal industry for its tube sheets and plates, in all the customary alloys. What is more natural than the close relations between the two companies, Revere the supplier, Braun the fabricator? Revere can furnish heavy plates when needed; Braun is one of the great heavy-duty shops of the country. So far as transportation limits permit, Braun fabricates in its own plant; their machines and their cranes can handle anything the railroads can haul away. The same is true of Revere, which is likewise known throughout heavy industry for its ability to produce not only large plates, but also condenser and heat exchanger tubes.

Revere is pleased to be an important supplier to Braun. Remember, good names find it good business to come together. The next time you want quotations on tube sheets and plates, and condenser tubes, get in touch with the nearest Revere Sales Office.

# REVERE COPPER AND BRASS INCORPORATED Founded by Paul Revere in 1801

Founded by Paul Revere in 1801 230 Park Avenue, New York 17, N. Y.

Mills: Baltimore, Md.; Chicago and Clinton, Ill.; Detroit, Mich.; Los Angeles and Riverside, Calif.; New Bedford, Mass.; Rome, N.Y. Sales Offices in Principal Cities, Distributors Everywhere. A Braun engineer inspects a drilled tube sheet.



been revised upward lated by companies that don't plan all their spending far in advance and by other companies that simply become more optimistic. And this year the drop in preliminary spending plans for one, two and three years hence is less than half as much as those reported in any previous McGraw-Hill survey.

Chemical process industries' spending plans for 1956 and 1957 are only about 6.5% below 1955 and already are nearly identical to total spending on new plants and equipment in 1954. Even as far ahead as 1958, preliminary plans have been made for spending 92% as much as in 1955.

On the basis of past survey experience, this year and the next three each stand an excellent chance of setting successive new records in capital spending by the chemical process industries.

Among the individual processing industries, chemical firms already have plans to spend more in 1957 and 1958 than this year. Capital spending should hold fairly steady in the rubber and ceramic (stone, clay and glass) industries through 1958. In the paper industry, current plans call for expenditures about 25% below this year's in each of the years 1956-1958. Petroleum companies now plan successive cuts in capital outlay for refining.

► Sales Will Boom-Behind these plans for continued high spending on new plants and equipment lie optimistic views on sales prospects.

#### Watch Out for These Survey Changes!

year's survey incorporates a number mining. of industry reclassifications designed

e.g., the chemical processing indus- of the Chase-Manhattan Bank. tries, the metalworking industries.

Give a mining figure that doesn't trade, (like government figures) include oil offices. well drilling, but which does include most mining expenditures by manu- this year's estimates are in most cases facturing firms. Previous statistics not comparable to those of the Dept. classified mining by manufacturers of Commerce, nor to those of past under manufacturing; here they are McGraw-Hill surveys.

To maximize its usefulness, this included, wherever possible, under

Give a petroleum figure that covers the entire oil industry. Base statistics Group similar industries together- were supplied by the Petroleum Dept.

> Include commerce-e.g., retail service, construction and

> The result of these changes is that

Companies in chemical processing expect their 1955 sales to be up 7% over 1954, and they expect 1958 sales to be 21% higher than last year. These expected increases, incidentally, are the same as the average reported by all manufacturing industries.

The largest rise in sales in the processing group are expected by chemical companies-9% this year, 26% by 1958. The smallest predicted increases are reported by petroleum companies-4% this year, only 15% by 1958. Paper and ceramic firms expect their sales to jump 20% over 1954 by 1958; rubber companies expect a 16% in-

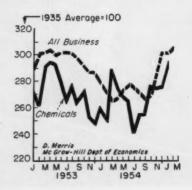
► Capacity's Rising, Too—In most of the chemical processing industries, companies report plans for

continued expansion of capacity over the coming four years. (The McGraw-Hill survey provides the only regularly available figures on capacity in all manufacturing.)

Reported capacity at the end of 1954 in the processing group was 312 (1939 = 100). Plans now call for expansion to 330 by the end of this year and to 389 by the end of 1958-6% this year and 16% over the following three years.

Chemicals proper and the paper industry report the largest planned capacity gains of the processing group for both 1955 and 1956-1958. Both industries expect to expand 7% in 1955. Chemical companies plan a further 22% by the end of 1958 and paper firms an added 16%. Rubber and ceramic companies both report plans to up

#### CONSUMPTION INDEX



Business Activity (March)	)
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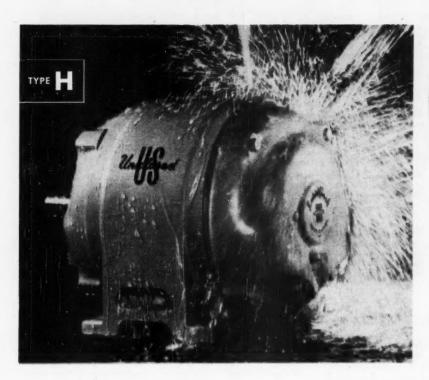
#### Chemical Consumption Feb. (Prelim.). . 280.9

Jan. (Rev.) . . . . . 290.7

Indexes	Feb.	Jan.	Paint & varnish	25.06	26.40
Fertilizer	70.13	69.74	Textiles	9.97	10.63
Pulp & paper	32.01	33.61	Coal products	9.98	11.85
Petroleum refining.	27.49	29.75	Leather	4.49	4.21
Iron & steel	15.58	16.21	Explosives	7.64	7.69
Rayon	27.10	28.51	Rubber	6.73	7.03
Glass		23.55	Plastics	21.60	21.53

## **NEW MOTOR PROTECTION**

# with INGENIOUS Tentrifoil





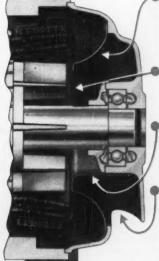
# Ventrifoil

## AT EACH END OF THE MOTOR DIRECTS AIR AND DEFLECTS

**WATER...** Ventrifoil, a specially formed deflector, directs air around bearing housings and into fans on the rotor. By forming a "vestibule" between the bracket openings and the fan inlet, water is deflected and separated from the air stream without hindrance of the air flow to interior.

# All New uniclosed Type H U.S. MOTOR

U. S. Motors new NEMA dimensioned Type H motor is an advanced development of the Uniclosed concept. In addition to Ventrifoil, Type H embodies a host of revolutionary exclusive features, such as improved asbestos-protected windings to add years to motor life; Lubriflush transverse lubrication for greatly increased bearing life; normalized castings; improved solid cast rotor; all directed to the objective of longer motor life and more efficient power.



#### VENTRIFOIL

Securely fastened to inside of bracket to direct air and deflect water. Does not interfere with assembly of motor.

#### AIR PASSAGE

Air is brought in at bottom but enters motor only through top half of deflector.

#### CURVED WATER FOIL

A curved projection of the Ventrifoil is concentric with the shaft and prevents entrance of water.

#### PROTECTED VESTIBULE

After entering bracket openings, air flows upward at low velocity through a protected chamber within bracket before reaching motor windings.

Mail Coupon for informative full-color 12-page Type H Bulletin 🛊

U. S. ELECTRICAL MOTORS P. O. Box 2058, Los Angeles S Milford, Conn. Send Type H B	54, Calif., or	CE-6		
NAME				No.
COMPANY				
ADDRESS			+	
CITY	ZONE	_STATE	131	

U.S. MOTORS

#### How Manufacturers Are Expanding Capacity (Index of Industrial Capacity, 1939 = 100)

	Jan.1				Plan	nned	P	ercent Increa	158	
	1946	1952	:953	1954	1955	1958	1953-54	1954-55	1955-58	
Primary metals	120	164	175	181	186	202	2%	3%	8%	
Metalworking	156	324	356	376	401	452	5	6	12	
Chemical processing	146	274	295	312	330	389	5	6	16	
Chemicals	172	357	393	417	446	544	6	7	22	
Peper	151	262	278	292	312	362	5	7	16	
Rubber	153	241	255	273	287	316	7	5	10	
Stone, clay, glass	112	217	230	239	251	286	4	5	14	
Petroleum refining	123	194	208	¥18	220	229	5	1	4	
Foods and beverages	117	157	162	168	176	192	4	5	9.	
ALL MANUFACTURING	131	204	218	229	240	266	5	5	11	

All other data as of end of year

#### How Sales Will Grow

	Percent Increase 1954– 1955	Percer Increas 1954 1958
Primary metals	10%	. 18%
Metalworking	7	23
Chemical processing	7	21
Chemicals	9	26
Paper	6	20
Rubber	7	16
Stone, clay, glass	8	20
Petroleum refining	4	15
Foods and beverages,	4	15
Textiles	8	17
Misc, manufacturing	8	23
All Manufacturing	7	21

#### More Emphasis on Expansion (Percent of Total Spending)

	195	4	195	5
	Expan- sion	Modern- zation	Expan-	Moderni- zation
Primary metals,	42%	58%	46%	54%
Metalworking	41	59	41 2	59
Chemical processing.	54	46	60	40
Chemicals	59	31	77	23
Paper	53	47	57	43
Rubber,	43	57	41	59
Stone, clay, glass.	45	55	62	. 38
Petroleum refining.	39	61	33	67
Foods and beverages.	42	58	33	67
Textiles	5	95	23	77
Misc. Manufacturing.	35	65	46	54
All Manufacturing	43	57	47	53

#### Operating Rates Today

1 End of 1954

	Current Rate <sup>1</sup>	Preferred
Primary metals	82%	87%
Metalworking	81	86
Chemical processing	88	92
Chemicals	79	92
Paper	97	97
Rubber	93	90
Stone, clay, glass	87	88
Petroleum refining	90	91
Foods and beverages	83	88
Textiles	88	92
All Manufacturing.	84	89

How Soon Manufacturers Think New Equipment Should Pay Out-Percent of Replies

Years:	1	2 -	3	4	5	6	7	8	9-pr-more
Primary metals	5%	5%	20%	10%	50%	0%	10%	0%	0%
Metalworking	5	14	18	18	59	5	1	3	7
Chemical processing	1	8	21	22	25	5	3	2	13
Chemicals	0	6	11	36	26	12	3	0	6
Paper	0	5	21	21	21	0	5	0	27
Rubber	0	20	40	10	10	10	0	10	0
Stone, clay, glass	5	5	27	0	32	0	5 .	5	21
Petroleum refining	0	7	29	29	29	0 .	0	0	6
Foods and beverages	6	16	16	16	25	4	0	6	11
Textiles	13	13	19	25	19	3	0	6	2
Misc, manufacturing		16	18	13	18	3	8	8	8
ALL MANUFACTURING	5	12	19	18	27	4	3	4	8

capacity 5% this year, with a further rise of 10% for rubber and 14% for ceramics by 1958. Petroleum refiners, though, plan only a 1% increase this year and 4% the following three years. All manufacturing plans call for a 5% increase this year, 11% in 1956-1958.

▶ Nearing Best Rates—These plans for continued expansion come on top of a 35% boost in capacity between 1950 and 1954 in the chemical process industries. And they reflect both optimistic sales forecasts and the feeling that production is already pushing against desired operating rates. Companies in these industries report that they were running at an average of 88% of capacity at the end of 1954, while they indicated that the preferred rate for most economical operations in their industries was 92%.

Among the individual segments, all except chemicals proper were operating at or near the preferred rate by the end of 1954.

Paper companies were running at the preferred rate of 97% of capacity. Rubber companies reported 93% operations as against a preferred rate of 90%. Ceramic firms reported an average operating rate of 87%, against 88% preferred.

And petroleum refiners cited a 90% rate, against 91% preferred.

But chemical companies were running at only 79% of capacity and indicated that the preferred rate for the industry was 92%.

► Accent on Expansion—This year's survey results point not only to a resumption of a rising trend in capital spending but also to reversal of a trend that had been running in favor of replacement and modernization rather than expansion.

In the chemical processing industries, 60% of this year's spending is being directed to expansion, compared with only 54% last year. In



# **NICHOLS HERRESHOFF\* Multiple Hearth Furnaces**

. used worldwide in many processing methods, some of which are listed below

#### Calcining

Lime sludge, bauxite, alunite, magnesite, limestone, colemanite, fullers earth. Furnace design permits many variations in heat treatment.

#### **Drying**

Efficient, economical dewatering of ores, concentrates, sludges, sand, chemicals, coal.

#### Regeneration

. . . of bone char, carbon and other filter media; catalysts, chemicals. Uniform reactivation and maximum adsorption at low operating cost.

#### Sand Reclamation

Scrubbing and thermal processing reclaims used foundry sand to good-asnew condition.

#### Roasting

Desulphurizing and treating ores and concentrates for the manufacture of acids and the production of many metals. Close temperature control, high tonnage rate.

#### Incineration

combustible plant wastes in raw or digested state to an easily disposable ash.

#### Roastina of sewage sludge and

Booton - Burns Process combined advantages of flash and hearth roasting.

At right: Nichols

Multi-Flash

#### Nichols Services

The Nichols organization is well staffed and equipped to render its clients the following:

- 1. Consultation services on research or operational problems.
- 2. Plant installation on

a "turn-key" basis. 3. Complete laboratory and pilot plant facilities for custom drying and heat treating or investigation into new methods.

We invite you to write for more information on any **Nichols Herreshoff furnace** application or Nichols engineering service.

\*Reg. U. S. Pat. Off.

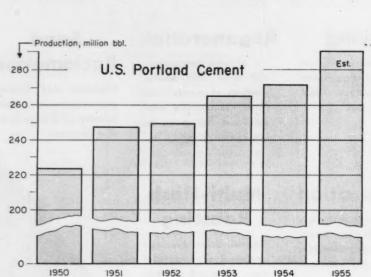
Nichols Engineering & Research Corp.

70 Pine Street, New York 5, N. Y. 1637 N. Illinois St., Indianapolis 2, Ind. 1477 Sherbrooke St. W., Montreal 25, Canada all manufacturing, over half of capital expenditures will still go to replacement and modernization, but the percentage is dropping from 57 in 1954 to 53 this year.

The proportion of expenditures going to expansion is up from 59% last year to 77% this year in chemicals proper, up from 45% to 62% in ceramics, and up from 53% to 57% in paper. Expansion's share is down slightly from 43% to 41% in rubber and from 39% to 33% in petroleum refining.

Companies cooperating in this

year's survey also reported on how soon they figured investment in new equipment should pay out (estimated before taxes). Chemical processing companies on the average reported about the same payout period as manufacturing companies as a whole—roughly two-thirds of the firms report from three to five years. This range was typical of the individual processing industries, too, except that 27% of the paper companies and 21% of the ceramics firms reported payout periods of nine years or more.



## Cement Hits All-Time High

Thanks to the construction boom, 1954 was a peak year. And this year will be even better

#### Roslyn K. Gitlin, Editorial Assistant

If 1954 and early 1955 figures are any indication of what the future portends, the portland cement industry is in for one of the most fruitful periods in its history—one of greatest expansion.

Last year's production set an alltime high. With plants operating at 91% capacity, a record 271.3 million bbl. were made (273.9 million bbl. shipped). Translated into terms of portland cement's basic constituents—lime, silica, alumina and ferric oxide—171.5 million bbl. of CaO, 57.8 million bbl. of SiO<sub>2</sub>, 17.3 million bbl. of Al<sub>2</sub>O<sub>2</sub> and 8.1 million bbl. of Fe<sub>2</sub>O<sub>2</sub> went into 1954's production.

And based on early returns, 1955 promises to be another record-breaker. January '55 shipments topped those of last January by 20%.

What's sparking the portland cement upsurge? The unprecedented construction boom. The U. S.

Dept. of Commerce reports 1954 construction expenditure at a record \$37 million, 5% over 1953. And the prediction for 1955 is even higher—\$39.5 million.

Nearly all private construction is increasing. Though a few months ago capital spending on manufacturing facilities seemed headed slightly lower in 1955, latest surveys (page 326) now indicate a 3% rise in spending by manufacturers this year. And since the trend appears to be turning in favor of plant expansion rather than replacement or modernization, particularly in the chemical processing industries, use of cement should get still another boost.

▶ Enlarged Road Program—The greatest boost to portland cement production is expected to come from the proposed federal and state highway programs. Assuming these program go through as planned, here's what domestic cement producers anticipate—capacity-wise—by the end of 1956 and 1959 (U. S. Bureau of Mines survey):

1956–338 million bbl.,
 15.5% over present theoretical capacity

• 1959–407 million bbl., up 38% over today's figures.

▶ Regional Shortages — Increasing demands for road construction may put the squeeze on other cement users. Already two producers in the Baltimore area are "sold out" until fall. If necessary, local distributors plan to import cement for uses that don't require American-manufactured cement.

Chicago producers feel that supplies may be tighter than last year. Toll roads and highways are expected to take more of the available cement.

In the Los Angeles area deliveries are on allocation and shortages are expected.

The New York-New England and Wisconsin-Michigan-Illinois-Indiana-Kentucky areas may also be in for shortages. Bureau of Mines figures indicate that greater highway programming in these areas would tie up enough production capacity to curtail much other construction. (Continued)

"THE BRAND OF PROGRESS"



▲ SYNOPSIS OF AD NO. 3: Western Supply Company, designers and manufacturers of heat exchangers for the Petroleum, Chemical and Petrochemical industries, is daily pursuing its own research program in an effort to advance the technology of heat transfer. This research is carried on through Western equipment installed at the University of Tulsa and as a cooperative effort with the Tubular Exchanger Manufacturers Association which sponsors heat exchanger research at the University of Delaware.

By Heat

Exchanger Specialists



A well known gas transmission company employed Western gas after-cooling equipment in their initial installation. As the gas demand and supply increased necessitating additional line capacity, varying ratios of compression were employed. Western engineers, collaborating with the transmission company, worked out section arrangements which minimized pressure drop during periods of high rate of flow yet provided adequate cooling during high compression ratio operation.

fourth in a new series of advertisements

Today's heat exchangers must answer exacting demands in widely varying temperature and pressure ranges. Standard and alloy metal fabrication is increasingly a matter of custom design, and the cost of heat exchangers has risen proportionately.

To hold exchanger pricing within reasonable and practical limits, Western Supply Company provides its customers with the services of an experienced staff of thermal and mechanical engineers...men who know heat transfer.

After studying specifications and consulting with the client, this group is charged with the responsibility of designing the exchanger to answer the need without superfluous material, labor or operational complications. In case after case this has meant savings to Western's customers.

The engineering staff stands behind every Western Heat Exchanger . . . you cash-in on this experience.



WESTERN SUPPLY COMPANY

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130 Casa Linda Plaza, Dallas 18, Texas
PROCESS INSTRUMENTS & EQUIP. CO. - North Bidg., Charleston, W.Va.
H. W. SEVERANCE—Marion E. Taylor Bldg., Louisville, Ky.

▶ Relief in Sight — Nonetheless, once the road programs are well under way, current portland cement industry-wide expansion is expected to alleviate the pinch in the above areas. At least a dozen companies have announced plans for or have already completed phases of plant capacity expansion. Among them:

 Universal Atlas Cement Co.,
 U. S. Steel subsidiary—building a new mill next to its Buffington,
 Ind., installation. This will boost the Buffington plant capacity to 10 million bbl. by mid-1956, making the firm's theoretical capacity about 36 million bbl. or 12% of the industry.

• Monolith Portland Cement Co.—completed the first phase of an expansion program designed to increase its plant capacity from 2.3 to 3.6 million bbl. By last October, production had been increased about 1,000 bbl. per day. And by mid-1955 an additional 1,000 bbl. per day increase is expected.

• California Portland Cement Co.—erecting a new 2 million bbl. cement plant near Mojave, Calif.

· Lone Star Cement Corp.-

at work on a two-year, \$14 million revamping and expansion program designed to increase capacity by 1.7 million bbl.

• Ideal Cement Co.—planned merger with Superior Portland Cement Co. is off. But Ideal expects a 3.5 million bbl. capacity increase by Jan. 1956. And in the engineering stage are expansion projects at its Mobile, Ala., Baton Rouge, La. and Houston, Tex. plants.

With new capacity in new plants about \$10 per bbl., the cement industry might spend upwards of \$1 billion-by 1959-for more output.

#### GUIDED TOUR CONTINUED



#### PICTURED FLOWSHEET

Better methanol synthesis................ 370

#### NAMES IN THE NEWS

#### TECHNICAL BOOKSHELF

#### FIRMS IN THE NEWS

Who's doing what among your suppliers..... 400

#### TECHNICAL LITERATURE

Manufacturers new literature..... 478

#### Better methanol synthesis.

Advances in equipment and process mark Commercial Solvent's new methanol unit. Here's how they make 29,000,000 gal. a year from natural gas. (p. 370)



#### Find it hard to keep up?

Maybe you should keep closer tabs on the new books coming out. Technical Bookshelf is your monthly guide. (p. 388)



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You can now get—free and fast—literature on any subject in your field. Keep your files up to date the easy way.



#### Join READER SERVICE Inside Back Cover

June 1955—CHEMICAL ENGINEERING



Crucible Steel Company of America



The ability of Nash Compressors to maintain original performance over long periods is no accident. Nash Compressors have but a single moving element, the Nash Rotor. This rotor is precision balanced for long bearing life, and it revolves in the pump casing without metallic contact. Internal lubrication, frequent cause of gas contamination, is not employed in a Nash. Yet, these simple pumps maintains 75 lbs. pressure in a single stage, and afford capacities to 6 million cu. ft. per day in a single compact structure.

Nash Compressors have no valves, gears, pistons, sliding vanes or other enemies of long life. Compression is secured by an entirely different principle of operation, which offers important advantages often the answer to gas handling problems difficult with ordinary equipment.

Nash Compressors are compact and save space. They run without vibration, and compression is without pulsation. Because there are no internal wearing parts, maintenance is low. Service is assured by a nation-wide network of Engineering Service offices. Write for bulletins now.

No internal wearing parts. No valves, pistons, or vanes. No internal lubrication. Low maintenance cost. Saves floor space. Desired delivery temperature Automatically maintained. Slugs of liquid entering pump will do no harm.

75 pounds in a single stage.

NASH ENGINEERING COMPANY
312 WILSON, SO. NORWALK, CONN.

# HOW FAST IS "WRITE-OFF"? In earnings from higher octane ratings, many refiners write off the cost of the Ljungstrom installation in less than two years. This time is cut to nine months and even less, when the other Ljungstrom advantages are taken into account saves up to 20% in fuel costs . . . permits more economical furnace design, with no need for convection surfaces . . . burns many fuels you used to throw away . . . results in consistently higher through-put . . . and minimizes slag. For more complete details on what the Ljungstrom Air Preheater can do for you . . . for an analysis of the heat recovery benefits obtainable in fuel burning equipment — call or write The Air Preheater Corporation. Wherever You Burn Fuel, You Need Ljungstrom The Ljungstrom operates on the continuous regenerative counterflow principle. The heat transfer surfaces in the rotor act as heat accumulators. As the rotor revolves, the heat is transfered from the waste gases to the incoming cold air.

# high quality product

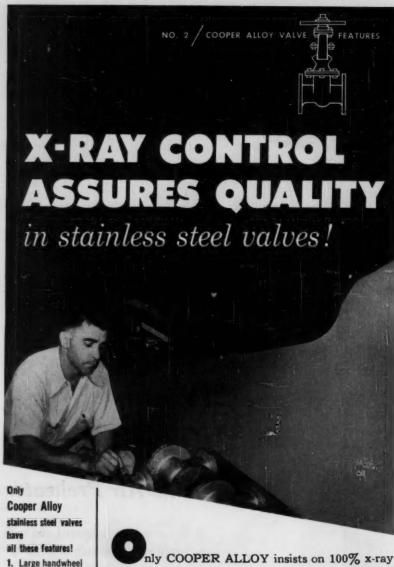
boost average
ratings
as much as
2 octane numbers
with the

### Ljungstrom® Air Preheater

With waste heat recovered and returned to the furnace in combustion air, the most modern heat-transfer systems can be operated at peak efficiency.

That's why you boost product quality with the Ljungstrom Air Preheater. It's heat-recovery efficiency makes possible advanced furnace designs that assure remarkably close control of processing. And finer control means a more uniform product . . . with average ratings as much as 2 octane numbers higher. One still's added income just from higher product quality is \$58,000 annually.

The Air Preheater Corporation 60 East 42nd Street, New York 17, N. Y.



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Cooper Alloy stainless steel valves have built such a reputation for reliable service.



2. Extra heavy seats

100% x-ray of

vital cast com-

stems, discs

5. Ball and socket

rotating type discs

6. Extra deep stuffing box

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Swinging eye-

9. Bowed yoke construction

Yoke cap de-

signed for quick

replacement

construction

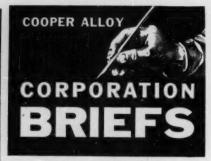
holts

ponents

4. Centerless ground stem

#### DPE CORPORATION . HILLSIDE, N. J.

Valve & Fitting Division



e Edited by GEORGE BLACK

#### CASTINGS ON PARADE

This interesting folder presents a variety of stainless steel cast parts with information as to alloy, weight and application. It contains a complete data chart listing twenty-eight alloys with recommendations for their use.



#### AIRCRAFT PRODUCTS DIVISION

The COOPER ALLOY AIRCRAFT PRODUCTS DIVISION now under construction at Clark, New Jersey is fast taking shape. It won't be long before it will be turning out the vitally needed jet engine rings at increased production rates and with substantial savings in critical materials such as nickel, and chromium. The latest in methods and equipment have been selected to guarantee high speed, high quality production with minimum waste.



#### SHELL MOLD FILM AVAILABLE

For those interested in getting a first hand look at shell mold techniques a short film on the subject is available from our technical librarian. Prepared by NBC cameramen for the National Association of Manufacturer's "Industry on Parade" television program, the film takes less than ten minutes, but it covers the ground pretty well.



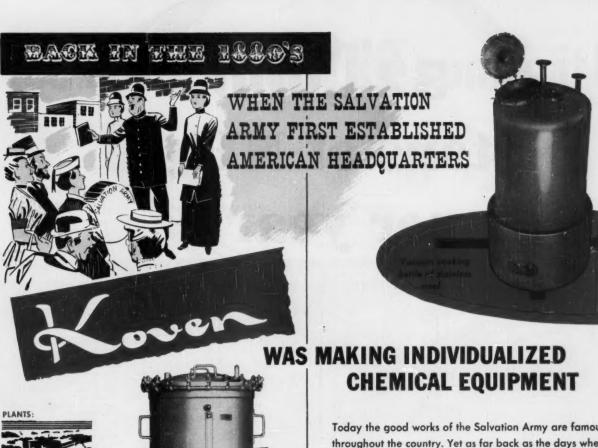
#### **BUY THROUGH DISTRIBUTORS**

An interesting discussion on the function of the distributor in modern day marketing and the advantages to the consumer in doing business on a local level are covered in detail in a reprint from SALES MANAGEMENT magazine. Prepared by Cooper Alloy's Distribution Manager, C. L. Heintz, the article is of interest not only to sales managers but to purchasing agents and company executives as well.



#### COOPER ALLOY

CORPORATION . HILLSIDE, N J.



Today the good works of the Salvation Army are famous throughout the country. Yet as far back as the days when only eight dedicated men and women comprised the entire American Salvation Army, KOVEN-built equipment was already in use—successfully increasing production and cutting costs for the chemical industry. Profit-minded manufacturers have long known that KOVEN Individualized Equipment—built to their exact needs—is the surest way to efficient, more economical output. Make KOVEN's over 70 years of steel fabricating experience work for you. Discuss your production problems with a trained KOVEN representative. There's no obligation—so call or write today for a consultation. Send for Bulletin #550.

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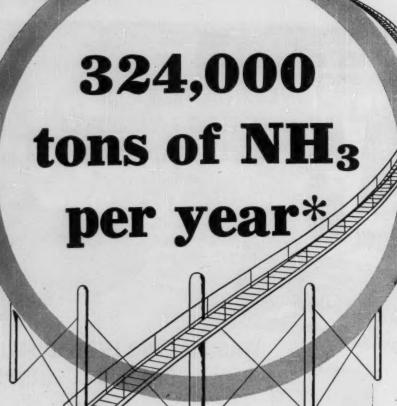
Fabrication to all A.S.M.E. Codes

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KOVEN FOR INDIVIDUALIZED EQUIPMENT SINCE 1881

X-Ray Inspection FOR QUALITY CONTROL

KOVEN equipment in all metals and alloys includes: High pressure vessels, extractors, mixers, stills, kettles, tanks, stacks, breechings. Shop and field erected storage tanks to 2 million gallons. High vacuum testing.



\*Combined yearly capacity out-put (est.) of following five am-monia plants using TRANE equipment:

equipment:
Spencer Chemical Company (1)
Vicksburg, Miss.
Grand River Chemical Division (1)
of Deere & Company, Pryor, Okla.
Cooperative Farm Chemicals (1)
Assn., Lawrence, Kan.
Grace Chemical Company (1)
Woodstock, Tenn.
The Atlantic Refining Company (2)
Philadelphia, Pa.
(1) Engineered by Foster Wheeler

(1) Engineered by Foster Wheeler Corporation. (2) Engineered by Hy-drocarbon Research, Inc.

## ... in plants using Trane Heat Exchangers

Higher outputs at lower temperatures! At -300° F. Trane **Brazed Aluminum Heat Exchangers are performing with** superior efficiency, economy . . . dependability !

THE FIVE MODERN AMMONIA PLANTS listed above-estimated total NH3 capacity 324,000 tons per year!-are but a few of the many modern plants using TRANE Brazed Aluminum Heat Exchangers for low temperature applications.

LOWER OPERATING COSTS, plus the ability to perform efficiently and economically at temperatures as low as -350 degrees F. explain why TRANE Brazed Aluminum units are used in so many new, modern air separation and ammonia plants. Even when large heat transfer duties are involved, they can obtain temperature approaches of 5 degrees F. or closer. Operating costs go down . . because less refrigeration is required to bring a specified liquid or gas to desired temperature!

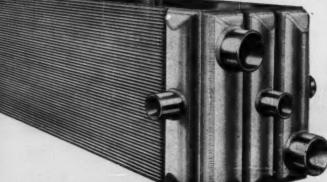
LOWER INITIAL COSTS—lower installation costs, too-are among the reasons for the steadily increasing use of TRANE Brazed Aluminum Heat Exchangers.

These compact, light-weight units pack up to 450 square feet of heat transfer surface into a single cubic foot. Units are now available for operating pressures up to 600 psig!

If you have a heat transfer problem involving low temperatures, multi-stream exchange or close approaches, it's time to call TRANE.

OUR 30 YEARS' EXPERIENCE in all phases of heat transfer is at your disposal. Just contact your nearest TRANE Sales Office or write on company letterhead to TRANE, La Crosse, Wisconsin.

Trane Brazed Aluminum Heat Exchanger of the type used for air separation, ammonia, and other low temperature separation processes.



One source, one responsibility for: Air Conditioning . Heating • Ventilating • Heat Transfer Equipment

The Trane Company, La Crosse, Wis. • Eastern Mfg. Div., Scranton, Pa. Trane Co. of Canada, Ltd., Toronto • 90 U.S. and 17 Canadian Offices

# You name it-MOYNO pumps it!



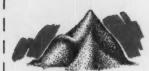
Potato salad, chow mein, peas, cream-style corn, tomatoes, molasses, chocolate,



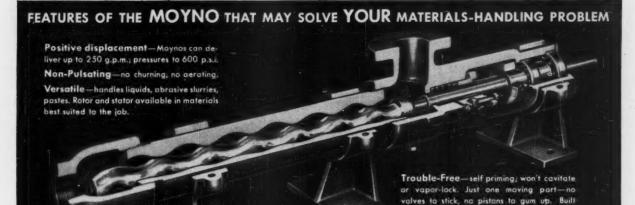
Caustics, acids, dyes, petroleum solvents, soaps, sludges, latex, synthetic resins.



Paper coating, starch, seam paste, size, adhesive dope, heavy grease, graphite sludge.



Insulator clay, frit, ground glass and water, porcelain glaze and enamel, cement, plaster.



## R & M Moynos handle almost anything that can pass through a pipe

The Moyno is a problem-solving pump. And whether your problem is one of materials, maintenance or flow, there's a betterthan-even chance that the Moyno is the pump you're looking for.

Here is a completely different kind of pump that handles almost anything that will push through a pipe, from free-flowing liquids to non-pourable pastes—even materials containing relatively large particles or abrasives.

This is how the Moyno works: a screwlike rotor turning within a double-threaded stator creates cavities which progress toward the discharge end of the pump, carrying the material being handled. The result is a

smooth, steady flow, free from pulsation and turbulence.

The pumping elements of the Moyno are available in a wide range of materials, depending upon the substances to be pumped. From stainless steels and synthetic rubber to tool steels, bronze, plastics-there is a Moyno that will do the job you want, and do it with remarkable efficiency.

Industrial-type Moynos are available with capacities to 250 g.p.m.; pressures to 600 p.s.i. Small Moynos (see inset), used as original equipment, serve on washers, water pumps, sprayers, and many other products.



for tough service. Easy to maintain.

FREE ... this informative bulletin

Tell us your pumping problem—let's see how the Moyno can help solve it. If necessary, we'll be glad to run tests for you in our own laboratories. In any case,

get the details on the Moyno-mail the coupon below.















Robbins & Myers, Inc. Pump Division, Springfield, Ohio	
Please send Bulletin 30C on Moyno Pumps	(CE)
Name	
CompanyTitle	_
Address	-
City	-
State	

Desk, Window, and Household Fans CHEMICAL ENGINEERING—June 1955



# Pick any four, plug in, and record

Here is a receiver recorder, custom-built by you to meet your needs, no matter how changeable, how complex. On a single chart you can record any four measured variables—and interchangeable receivers permit new combinations almost at will.

Individual plug-in pneumatic or electronic receivers—and corresponding integrators—are interchangeable in the four identical frame slots. You can select any combination; even including two receivers and their two integrators.

Think what this can mean to you! Parts inventories are minimized; re-use of components keeps instrumentation costs economically low when cycle changes are frequent—and you can even tie in with your existing transmitters.

Ask for Product Specification E12-5.

#### % combustibles combustion conductivity density differential draft flow liquid level % oxygen PH position pressure ratio smoke density specific gravity speed temperature vacuum

ONLY BAILEY OFFERS ALL THESE
ADVANTAGES IN A SINGLE RECORDER

- · Pre-calibrated plug-in receiver units
- Up to four pneumatic or electronic receivers
   —or two receivers and two integrators
- Any four variables on one chart—easily read and interpreted
- . A full year's ink supply at one loading
- Faster ordering—from stock
- Minimum inventory of parts
- Minimum instrument investment for process cycle expansion or alteration

BAILEY METER COMPANY

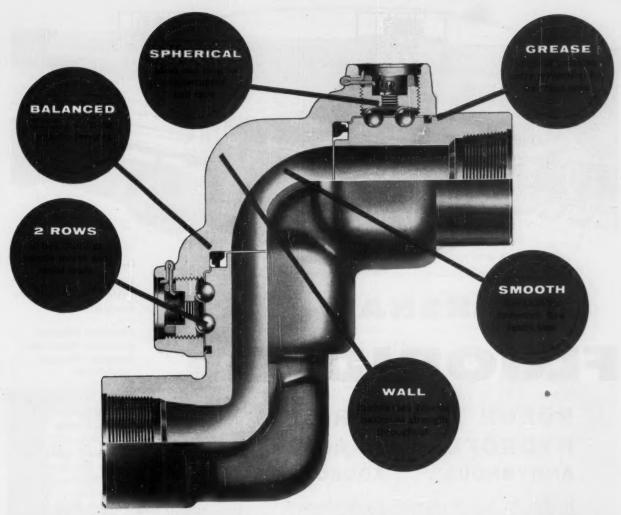
1054 IVANHOE ROAD

Controls for Power and Process



Controls for TEMPERATURE PRESSURE GAS ANALYSIS FLOW LEVEL

ratio density



## precision engineered for your service

Ball-Bearing Swivel Joints are precision engineered like a fine watch to give unlimited flexibility and unlimited service in the conduct of fluids, gases and liquids.

is the originator and largest exclusive manufacturer of ball-bearing swivel joints in the world today.

produces packing designs for specific service requirements, assuring constant torque at any given pressure.

has acquired a world-wide recognition for highest quality of product and lowest maintenance costs.

has over a quarter of a century of "know-how" in the design, manufacture and successful scientific application of ball-bearing swivel joints in industry.

offers the widest range of styles, sizes and pressures available for every major industrial use today.

has complete nation-wide coverage of its products and applications by qualified field service engineers.

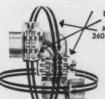
will custom engineer for you the solution to any problems involving the transport of fluids, gases and liquids.



Write CHIKSAN for latest INDUSTRIAL CATALOG—G-4 Dept. CE-6 Supply and Service of CHIKSAN Ball-Bearing Swivel Joints is always as near as your telephone.



Ball-Bearing Swivel Joints



CHIKSAN Ball
Bearing Swivel Joints are
THE NEW TOOL of
Modern Industry with full
360° retation in 1, 2, and 3
planes. Over 1,000
different types, styles,
and sizes have been
developed for pressures
and services from 28"
vacuum to 15,000 psi
and for temperature
ranges from minus 70°
to a plus 500° F. with
packing materials for
each specific service.

CHIKSAN COMPANY . BREA, CALIFORNIA . Chicago 3, Illinois . Newark 2, New Jersey

Well Equipment Mfg. Corp. (Division), Houston 1, Texas • Subsidiaries: Chiksan Export Co., Brea, Calif.; Newark 2, N. J. • Chiksan of Canada Ltd.. Edmonton. Alta.



#### HARSHAW

**FLUORIDES** 

# BORON TRIFLUORIDE HYDROFLUORIC ACID ANHYDROUS ... AQUEOUS

Harshaw has been a pioneer in the development of fluorine bearing products with a background of over 40 years experience as a major producer of Hydrofluoric Acid.

If required, you are invited to draw on the knowledge and experience of our staff of technical specialists on fluorides. Broadly, we offer you the benefit of our accumulated experiences in engineering problems involving corrosion, safe handling and storage facilities.

WRITE for Harshaw's 40-page Book on Hydrofluoric Acid Anhydrous. It provides helpful data for you if you now use HF or are considering its use.

#### THE HARSHAW CHEMICAL CO.

1945 East 97th Street • Cleveland 6, Ohio Chicago • Cincinnati • Cleveland • Detroit • Houston Los Angeles • New York • Philadelphia • Pittsburgh Here is an additional group of productioncontrolled, high-quality fluorides:

Ammonium Bifluoride Ammonium Fluoborate Antimony Trifluoride

Sublimed Barium Fluoride Bismuth Fluoride Boron Trifluoride Boron Trifluoride

Complexes
Chromium Fluoride
Copper Fluoborate
Fluoboric Acid
Fluorine Cells
Fluorinating Agents
Frosting Mixtures
Hydrofluoric Acid
Anhydrous

Hydrofluoric Acid
Aqueous
Hydrofluosilicic Acid
Lead Fluoborate
Metallic Fluoborates
Potassium Bifluoride
Potassium Chromium
Fluoride

Potassium Fluoride
Potassium Fluoride
Potassium Titanium
Fluoride
Silico Fluorides

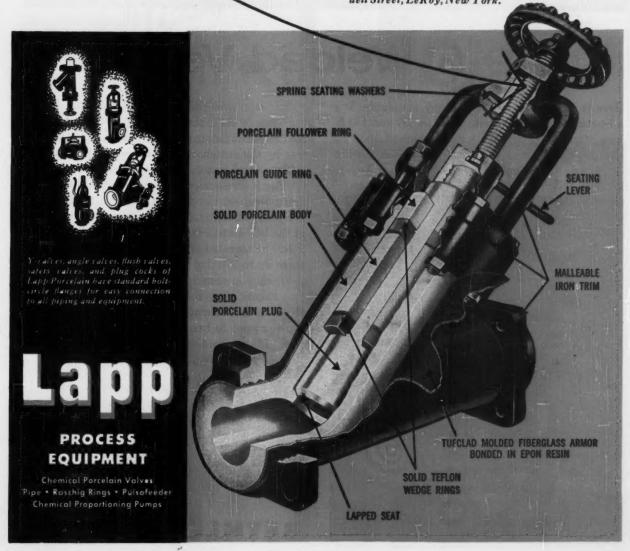
Silico Fluorides Sodium Fluoborate Tin Fluoborate Zinc Fluoborate Zinc Fluoride



# Easy working and long life in chemical atmospheres ... for the Lapp Valve

Non-ferrous working parts in the Lapp Valve eliminate freeze-ups from scales of corrosion. Threaded stud, yoke bushing and nuts, and plug cap are all brass or bronze, which keep the valve smoothly operative in all but the most unusual conditions of chemical atmosphere. Flange, yoke and gland are of high strength malleable or ductile iron, and are protected with baked-on Epon-base acid-proof paint. Flanges are permanently bonded to porcelain or armor with acid-proof resin cement. Write for bulletin with com-

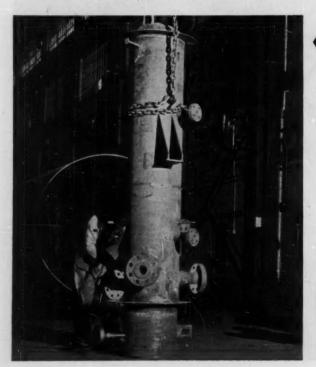
Write for bulletin with complete description, characteristics, and specifications. Lapp Insulator Co., Inc., Process Equipment Division, 415 Wendell Street, LeRoy, New York.





## 149-ft Welded Vessel

Here is a good-sized vessel by any standards. It's a 54-ton steam curing fank, 7 ft 6 in. ID and 149 ft long. It was fabricated at our weldment shop at Bethlehem, Pa., and is shown in the upper picture on its way to the customer's plant in New Jersey.



Fabricated according to the ASME 1952 code, the vessel's shell consists of %-in.-thick plates of ASTM A-285 Grade C flange-quality steel. Welding was by the automatic submerged-arc process.

The vessel was designed for temperatures up to 650 deg F. Pressure-wise, however, it is not unusual, being designed to operate at about 120 psi.

By way of contrast, the welded surge drum shown at the left is small but mighty. Only 11 ft 4 in. high, it will be operated at over 2700 psi, and at temperatures up to 670 deg F.

When you need welded vessels, we suggest that you submit your requirements to Bethlehem. Our shops at Bethlehem, Pa., and at Beaumont, Tex., are equipped to handle jobs of any size or description. Please contact the Bethlehem sales office nearest you for further information.

#### BETHLEHEM STEEL COMPANY BETHLEHEM, PA.

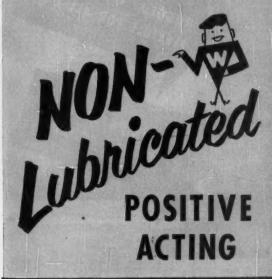
On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast eel Carporation. Export Distributor: Bethlehem Steel Export Corporation

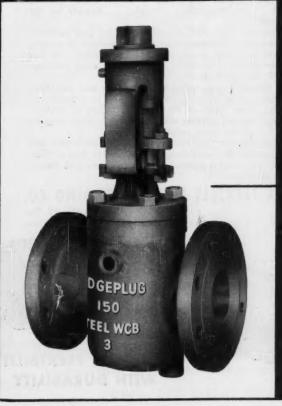


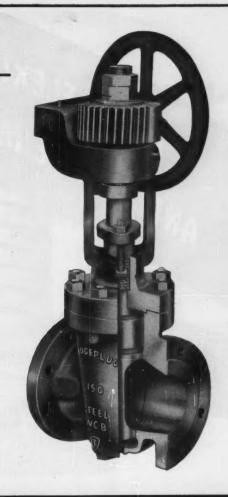
# For GENERAL SERVICE

Dependable performance at a wide range of temperatures and pressures, without the need for a plug lubricant, has made Wedgeplug Valves an international favorite.

Scientifically designed so that the plug lifts, turns, and reseats on its protected seating surfaces, in one conventional operation.







# WEDGEPLUG

NON-LUBRICATED
STEEL PLUG VALVES

## STEAM-JACKETED

For Handling Viscous Liquids

For Special Services—handling products that will harden or congeal at ordinary temperatures, such as: asphalt, pitch, petroleum residue, tar, resins, vegetable and animal fats, soap, sulphur, etc.—Wedgeplug Valves can be supplied Steam-Jacketed.

Write for Wedgeplug Catalog No. 54-1-W

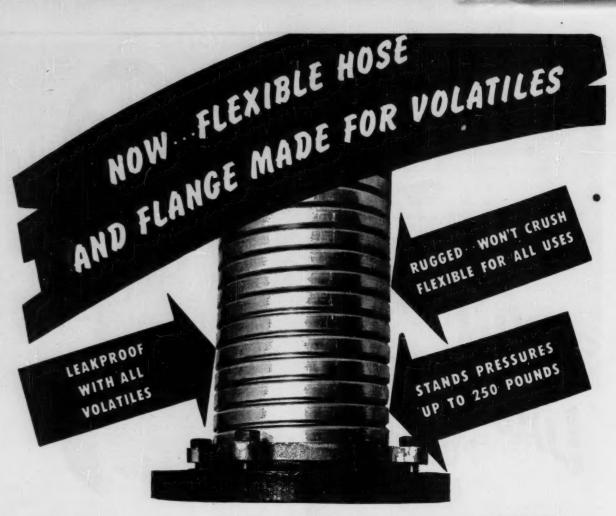
WEDGEPLUG VALVE COMPANY, INC.

NEW ORLEANS 25, LA.

An Affiliate of

STOCKHAM VALVES & FITTINGS

GENERAL OFFICES AND PLANT . BIRMINGHAM 2, ALA.





Now, Penflex offers you the hose and flange to handle highly volatile liquids. It won't leak . . . is rugged . . . tough . . . flexible for the the most severe service.

This new hose has been designed, developed, tested and performance-proved in the chemical, petroleum and other industries conveying volatile liquids. It will withstand pressures up to 250 pounds and has proved its value in conveying oil, gasoline, kerosene and other volatiles. Available in sizes 2½" to 20" I. D.

The new Penflex Titepak Flange has patents pending and completes this leakproof assembly. It is leakproof under severe conditions . . . lighter in weight than other types of flanges . . . easier to connect. Penflex Titepak Flange assures greater efficiency in handling volatiles

. . . lasts longer . . . and is tamperproof.

Penflex manufactures a complete line of four wall interlocked and seamless welded corrugated flexible tubing and automatic barrel fillers for the petroleum and chemical industries . . . accessories and fittings . . . and pneumatic rivet passers.

#### PENNSYLVANIA FLEXIBLE METALLIC TUBING CO.

7234 Powers Lane

Philadelphia 42, Pa.

Branch Sales Offices-BOSTON . NEW YORK . CLEVELAND . CHICAGO . HOUSTON . LOS ANGELES



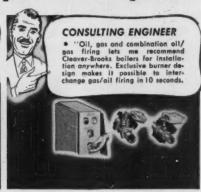


# CLEAVER-BROOKS SELF-CONTAINED BOILERS HAVE THE FEATURES EVERYONE WANTS!

## ... which feature would be most important to you?

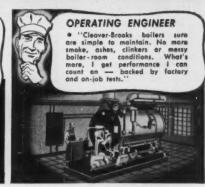


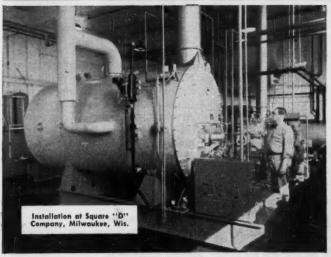
# ARCHITECT • "Self-contained design certainly simplifies boiler room planning — gives owners maximum use from each square foot of space. Gives me flexibility to make best use of low head room conditions."











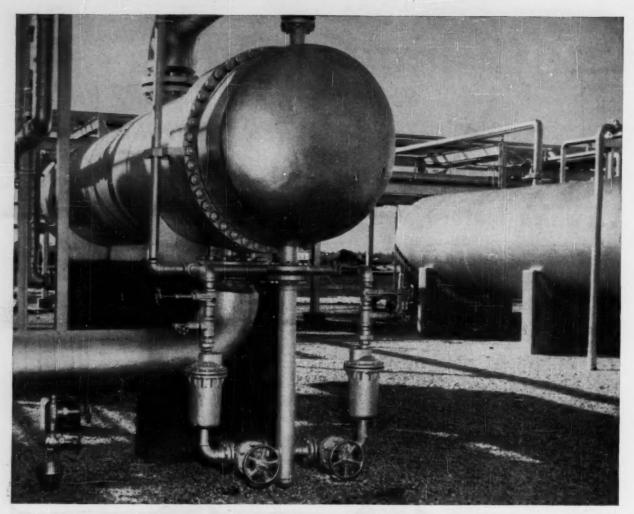
THESE are just a few of the many outstanding features that have made more than 15,000 individual Cleaver-Brooks self-contained boilers first choice for commercial, institutional and industrial applications. Get in touch with your nearest Cleaver-Brooks representative for complete facts, or write for catalog AD-100. Cleaver-Brooks Co., Dept. G-345 E. Keefe Ave., Milwaukee 12, Wis., U.S.A. — Cable address: CLEBRO — Milwaukee — all codes.



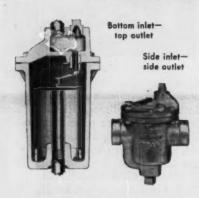
"It's NEW — get the facts on the CB boiler — write today!"

BOILERS - STEAM OR HOT WATER - FOR HEATING OR PROCESSING IN SIZES FROM 15 TO 500 HP, 15 TO 250 PSL

NOW - FIRST SIZES OF THE CB BOILER ARE MADE IN CANADA, TOO.



## A Look at Low Cost Maintenance . . .



Corrosion- and wear-resistant materials; "frictionless" leverage; precision workmanship — add up to LOW MAINTENANCE.

JUST a couple of steam traps struck out in a cycling plant, along with a lot of valves and piping . . . that's what the picture shows. What the picture doesn't show is the big reason for the choice of those two Armstrong traps: low cost maintenance.

There is a tremendous investment in capital equipment riding on the performance of such small auxiliaries as steam traps. They have to work right 24 hours a day. Troublesome traps can eat up maintenance time like the desert can soak up water. That's why a photographer could work 'til doomsday without getting pictures of all the Armstrong traps in petroleum plants around the world. They've

proved themselves on the maintenance score!

Only two moving parts... no sliding fits, no fixed pivots... file-hard chrome steel valve and seat... corrosion-resistant stainless mechanism... heavy reinforcement of wearing parts... generous safety margins... precision workmanship... factory testing of every trap—these are the things that pay off in long, long service life with infrequent maintenance. Ask your Armstrong Representative to show you the technical fine points that make such a big difference. Or, write:

ARMSTRONG MACHINE WORKS 858 Maple Street • Three Rivers, Michigan

Application Engineered
ARMSTRONG STEAM TRAPS

THE STEAM TRAP BOOK...
Tells more about traps and trapping—44-pages of useful data free on request.



58



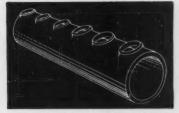
## simplifies piping construction, reduces costs

TUBE TURNS now offers custom-made Manifold Welding Fittings with size, wall thickness, and number of outlets as required by your service conditions. These manifold fittings are available in all commercial metals and alloys.

Use of TUBE-TURN\* Manifold Welding Fittings provides stronger and safer outlet connections than are possible when pads and saddles are employed. This new fitting makes possible greater economy and speed of construction in many

types of service. It is particularly useful when outlets are smaller than one-half the run pipe diameter, when they are extremely close together, or when they must vary in size.

This new addition to Tube Turns' line enables you to "specify TUBE-TURN" for all your tee and manifold fitting requirements. For prompt, helpful service, get in touch with your Tube Turns' Distributor. You'll find one in every principal city.



The new TUBE-TURN Manifold Welding Fitting . . . superior to pad and saddle construction . . . easy to install . . . dependable in service.

TUBE-TURN Welding Fittings and Flanges are made in U.S.A.

They meet all U.S. piping code specifications



"TUBE-TURN" and "tt" Reg. U. S. Pat. Off.

# **TUBE TURNS**

LOUISVILLE 1, KENTUCKY

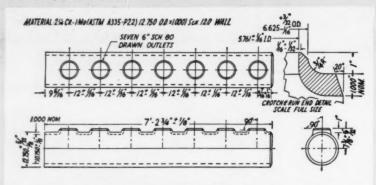
A Division of National Cylinder Gas Company

DISTRICT OFFICES: New York - Philadelphia - Pittsburgh - Claveland - Datroit - Chicago - Danver - Les Angeles Son Francisco - Seattle - Atlanta - Tulsa - Houston - Dallas - Midland, Texas

(77) (8000) (1800) (1800) (1800) (1800)

# Why TUBE-TURN Manifold Welding Fittings give you safer service

In conventional pad and saddle construction, the transition to the side section of the branch is abrupt, creating stress concentration, often leading to failure. The TUBE-TURN\* Manifold Welding Fitting with integral extruded outlets, is superior in strength. It provides a smooth transition from the pipe run to the smaller, thinner-walled outlets, and is thus better able to withstand cyclic stress from pressure or temperature changes.



12" Manifold with Seven 6" Outlets. Schedule 80.



TUBE-TURN Manifold Welding Fitting being installed in a measuring station of a large west coast gas utility.

#### CODE APPROVED

TUBE-TURN Manifold Welding Fittings are in full accordance with the latest recommendations of ASA B31.1 Subcommittee No. 8.

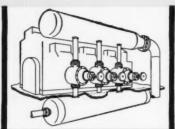
TUBE-TURN Manifold Welding Fittings comply with the requirements of ASA B16.9 and ASTM A234 covering the design and manufacture of butt welding fittings.

## TYPICAL

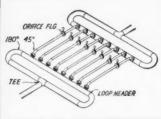
TUBE-TURN Manifold Welding Fittings can be used in virtually all types of major piping systems. Tube Turns' Sales Development Department will be glad to assist you in application problems.



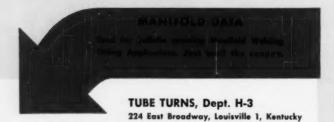
Pipe Still or Charge Heater



Compressor Station Suction and Discharge Headers



Meter Run Loop Header



Please send bulletin on new Manifold Welding Fittings.

Company Name \_\_\_\_\_\_

Company Address \_\_\_\_\_\_

City \_\_\_\_\_ Zone \_\_\_\_ State \_\_\_\_\_

Your Name \_\_\_\_\_



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""TUBE-TURN" and "tt" Reg. U. S. Pat. Off.

## TUBE TURNS

A DIVISION OF NATIONAL CYLINDER GAS COMPANY
LOUISVILLE 1, KENTUCKY



GENERAL ANILINE COLORIST SAYS . . . .

# "G-E Spectrophotometers Are Invaluable for Production-line Color Analysis"

"Even the most complicated color-matching problems are taken in stride by General Electric's recording spectrophotometers," says Irving W. Feyler, Colorist at General Aniline & Film Corporation, Rensselaer, New York.

Rapid production-line analysis of dyes by G-E spectrophotometers help General Aniline technicians maintain constant color control. A complete spectrophotometric curve of the most complex dyestuffs can be drawn in only 54 seconds.

MATERIAL SAVINGS are assured because costly mismatching of dyes for textile, plastic, paint, ink, paper, and other products is practically eliminated.

Versatile and accurate, the G-E spectrophotometer has a range of 380 to 700 millimicrons.\* The instrument will measure both transparent and opaque samplings.

Additional savings are made by using the automatic tristimulus integrator. Provided as an accessory to the spectrophotometer, the integrator automatically calculates numerical color values at the completion of the spectrophotometric curve.

FOR MORE INFORMATION, contact your nearest G-E Apparatus Sales Office, or write for bulletin GEC-307 to General Electric, Section 585-18, Schenectady 5, N. Y.

\*Special ranges can also be provided.

# GENERAL ELECTRIC

1. INSERTING SAMPLE and standard color specimens into G-E spectrophotometer, operator prepares to run test.

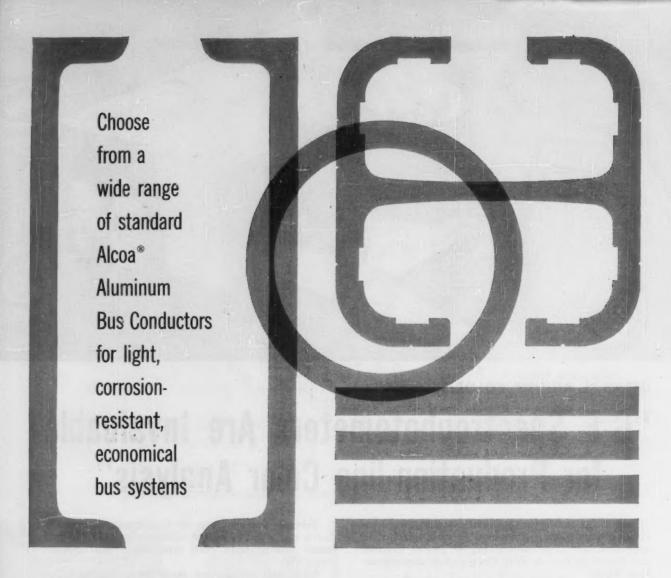
2. SELECTING RECORDING SPEED is next step. Color measurement is automatically recorded by G-E instrument.

3. ANALYSIS AND COMPARISON of test and standard curves is final step in accurate production-line color control.









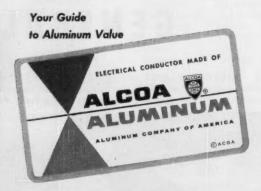
Whatever your installation or bus design problem is, there's an Alcoa Aluminum Bus Conductor so right for the job it's almost custom fabricated. Alcoa has developed shapes, alloys and tempers to meet the mechanical and electrical requirements for any bus conductor application. Let us help you design your job in aluminum to get the most out of the many available types of Alcoa Aluminum Bus Conductors. Ask your nearest Alcoa sales office for assistance or address Aluminum Company of America, 2309-F Alcoa Building, Mellon Square, Pittsburgh 19, Pennsylvania.



Tensile properties of Alcoa Aluminum Bus Bars are checked on this Baldwin-Southwark tension-testing machine, periodically calibrated to assure precision.



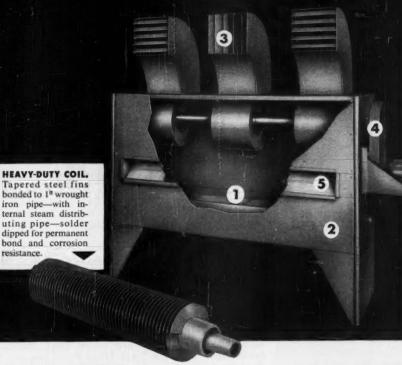
A precision potentiometer records the voltage drop on test sections of Alcoa Aluminum Bus Bar in the Massena, New York, laboratories, world's largest facility for aluminum conductor research.



ALWAYS USE ALCOA ALUMINUM ACCESSORIES WITH ALUMINUM CONDUCTORS

# Fact:

Rugged Westinghouse Industrial Heaters
available in 24 Sizes . . . 8 Coil Selections . . . 150 Ratings
from 100,000 to 2,500,000 BTU/hr . . . 2,000 to 25,000 CFM each



- 1. Proven, Westinghouse-manufactured, extended surface heating coils good for continuous operation up to 200 psig.
- Die-formed casings with rounded corners eliminate accidents and dirt catching pockets. Front and back panels easily removable.
- 3. Multiple louvered outlets for efficient distribution of heated air.
- 4. Self-aligning, grease-lubricated ball bearings mounted outside casing, readily serviceable.
- **5.** Face and by-pass dampers permit continuous air circulation to maintain uniform temperatures.

NOTE: Louver type mixing box accessory permits introduction of fresh air for make-up and ventilation, with or without filters.

Solve your space heating problems with Westinghouse-Sturtevant Industrial Heaters. Eliminate cold, drafty conditions caused by excessive cold infiltration through leakage or exhaust.

#### **Two Types With Wide Applications:**

GENERAL PURPOSE HEATER... For manufacturing areas, warehouses, garages, commercial buildings—with standard non-ferrous heating coils.

HEAVY-DUTY HEATER... For continuous-duty high-pressure systems, or industrial process work—with wrought iron heating coils.

The compact packaged engineering of every Westinghouse-Sturtevant Industrial Heater provides units for mounting on floor, walls, or suspended from ceilings. In short, they can be placed where they will do the most good, and can be relocated to meet any change in plant layout.

Every unit is backed with a Westinghouse exclusive one warranty. Only Westinghouse makes all principal components—Fans, Heating Coils, and Motors. You can get unit engineering and single equipment responsibility.

MORE FACTS? To find out how to solve your particular heating problem, call your Westinghouse-Sturtevant Sales Engineer...he is the "Man With The Facts" on heating, air handling, and electronic air cleaning... or fill in coupon below.

#### WESTINGHOUSE AIR HANDLING

YOU CAN BE SURE ... IF IT'S

Westinghouse

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Sturtevant Division, Dept. 15E
Hyde Park, Boston 36, Mass.
Please send more information on your Industrial Heaters.
NAME AND TITLE
COMPANY
CITYSTATE





# You Can See Why SARAN LINED PIPE

## is your answer to downtime losses

It's made of corrosion-resistant saran pipe swaged right inside rigid steel pipe . . . two pipes in one for longest-lasting performance.

Here's really trouble-free piping . . . saran lined pipe, fittings and valves! This modern piping has a durable inner lining that eliminates shutdowns due to corrosion . . . forms tight-fitting joints that prevent leakage. Saran lined pipe, fittings and valves won't burst under working pressures up to 150 psi . . . and saran lined cast steel fittings are available for even higher pressures. Every single piece of saran lined pipe, fittings and valves is carefully spark-tested by hand to be sure there are no pinpoint holidays or cracks in the lining.

Installation costs are low with saran lined pipe, fittings and valves, too. They can be cut and threaded in the field with modified pipe-fitter's tools. And because they're rigid, few supporting members are needed.

If your operation requires the conveying of acids, alkalies, solvents and other corrosive liquids, be sure to investigate saran lined pipe, fittings and valves today. For further information, write the Saran Lined Pipe Company, 2415 Burdette Avenue, Ferndale 20, Michigan, Dept. SP529A.

RELATED SARAN PRODUCTS—Saran rubber tank lining • Saran rubber molding stock • Saran tubing and fittings • Saran pipe and fittings.

SOME OF THE MANY INSTALLATIONS USING

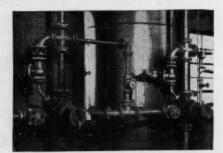
SARAN LINED

STEEL PIPE

Saran Lined Pipe is Manufactured by The Dow Chemical Company Midland, Michigan



Hydrochloric acid has been conveyed in this installation for well over seven years. Service has been eminently satisfactory.



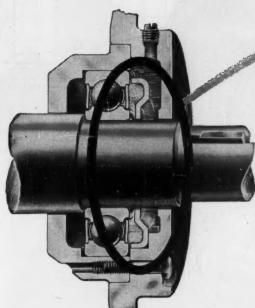
Saran lined pipe is used here in an automatic water de-ionizer. This installation has also had a long record of uninterrupted service.

you can depend on DOW PLASTICS -



# RELIANGETERMATIC

You can't grease 'em wrong!



## NEW METERING PLATE

provides the <u>right</u> amount of lubrication for A-c. and D-c. motors

No over or under lubrication is possible... you can't grease 'em wrong!

This is your sure answer to reliable greasing to eliminate burned-out motors.

Grease is metered to the bearing in just the right amount at all times.

Get in touch with the Reliance sales office or distributor near you for more details.



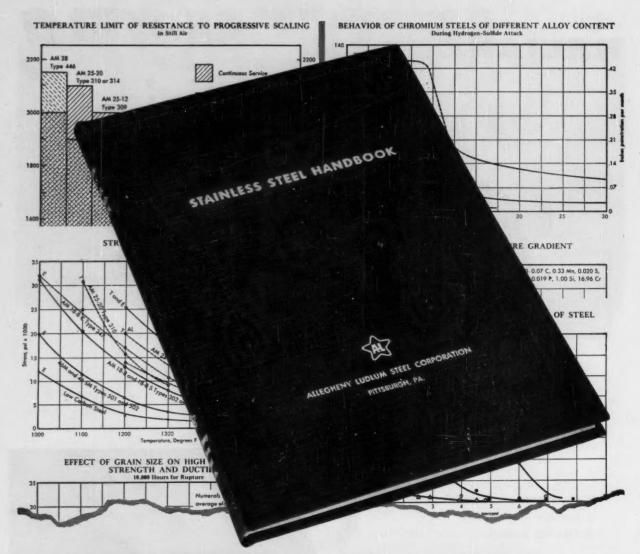


## RELIANCE ELECTRIC AND

1063 IVANHOE ROAD . CLEVELAND 10, OHIO
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Builders of the Tools of Automation





# Here's 124 Pages of Valuable Data on STAINLESS STEEL

Stainless and heat resistant steel can usually be classed as a critical material, since it not only contains strategic alloys but is indispensable in many vital industrial and armament applications. It is always important, therefore, to make every pound go as far as possible.

The latest edition of our comprehensive 124page, case-bound Stainless Steel Handbook is ready for distribution now. It will help you to select the right stainless steel and to use it properly. Comprehensive listings of analysis, properties and characteristics of each type will guide you in specifying grades that will do your job most efficiently. Clear, concise fabrication data will help you speed production and cut waste.

Your copy of the Stainless Steel Handbook will be sent—without charge—upon request. Our only stipulation: please make your request upon your company letterhead. • Write Allegheny Ludlum Steel Corporation, Oliver Building, Pittsburgh 22, Pa.

ADDRESS DEPT, ICE-66

You can make it **BETTER** with

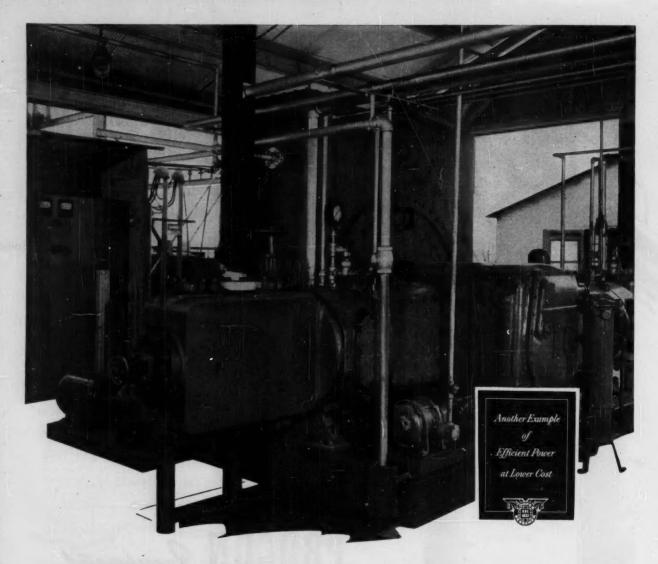
# **Allegheny Metal**

Warehouse stocks carried by all Ryerson Steel plants



## STATESMEN OF TECHNOLOGY





## Cooper-Bessemer Compressors operate "on their own"

ACTUALLY, the statement that Cooper-Bessemers are "on their own" is far from an exaggeration. For example, this single stage Cooper-Bessemer FM-2 compressor, installed in a Michigan refinery, runs 24 hours a day without operating personnel.

This money-saving advantage is made possible by highly efficient Cooper-Bessemer controls which automatically handle all phases of the compressing operation.

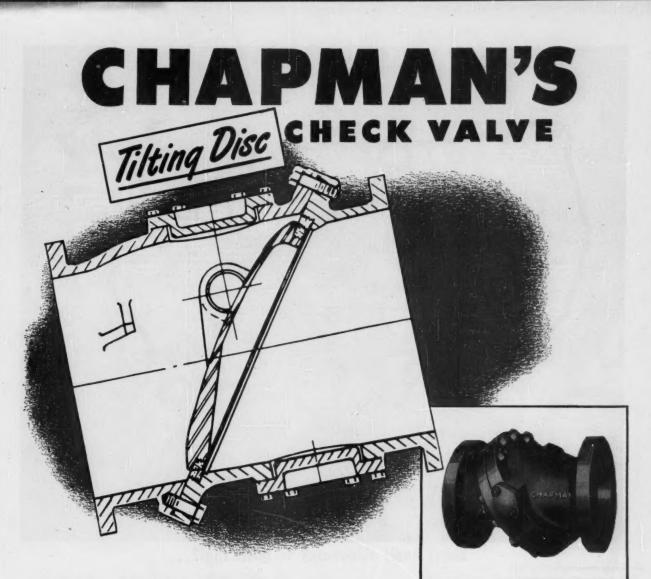
Moreover, in this plant's processing, contamination by oil is completely avoided. Therefore, the FM unit is equipped with Cooper-Bessemer carbon pistons, operating against micro-honed mirror finish liners, requiring no lubricating oil whatever! — a highly important factor in various processes involving compressed air and other gases.

Whatever your compressor requirements may be, from 100 to 5000 hp, Cooper-Bessemer offers you unique advances assuring the highest efficiencies combined with lowest cost operation. Your nearest Cooper-Bessemer office will gladly give you the specific information you may require.

COOPER-BESSEMER
GROVE CITY, PENNA.

New York City • Seattle, Wash. • Bradford, Pa. • Chicago, Ill.
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DIESELS • GAS ENGINES • GAS-DIESELS • ENGINE-DRIVEN AND MOTOR-DRIVEN COMPRESSORS



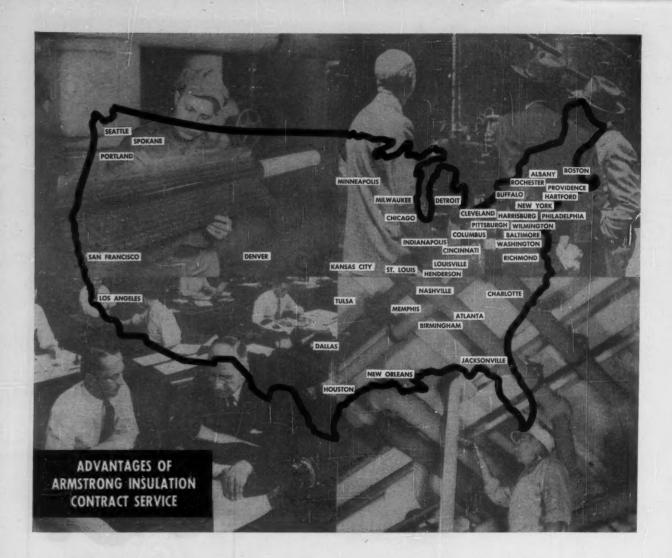
# Stays Open Without Flutter, Closes Fast Without Slamming

Chapman's Tilting Disc check valve keeps maintenance costs down in the entire piping system. There's no flutter or vibration in the open position: the lightweight, airfoil-designed disc is held firmly against its stops by the fluid flow.

When flow starts to reverse, the uniquely designed disc swings quickly to the closed position, cushioned by fluid pressures, and then drops to a tight seal against the seat, without sliding or scraping. Closure is fast, tight . . . and quiet. Slamming is eliminated, in all but unusual piping arrangements.

Freedom from vibration and slamming, low wear and low head loss keep maintenance costs down, give years of more efficient service. For every check valve service, specify Chapman's Tilting Disc. Available in steel or iron, with suitable trim to meet service conditions. Full engineering data are in Catalog 30. Write for it today.





## Nation-wide service . . . 43 offices give you insulation help anywhere

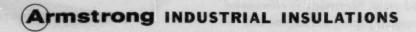
No matter where your next insulation job may be, Armstrong can give you efficient, well-integrated, on-the-job service from original specs to final installation

If your job is some distance from home, Armstrong engineers will help your home office staff develop plans and specifications. Then your decisions will be efficiently carried out by the Armstrong office in the territory where the installation is to be made. An Armstrong engineer is always close at hand, eliminating misunderstandings and long-range communications.

Whether your job requires high- or low-temper-

ature insulations, the Armstrong Insulation Contract Service provides a full line of materials. Experienced engineers, assisted by trained superintendents and foremen, oversee your job from start to finish. And if you have special problems, the facilities of the Armstrong Research and Development Center are always available to you.

Get full information on how the Armstrong Insulation Contract Service can help you from your nearest Armstrong office. For a free booklet on Armstrong Industrial Insulations, write Armstrong Cork Company, 2006 Sharpe Street, Lancaster, Pennsylvania.



# ship kid-glove chemicals in Hackney Drums



Here's the returnable shipping container to protect your sensitive chemicals, oils, and food products against contamination during shipment or in storage. Tight head or removable head Hackney Drums are available in several types of stainless steel—or in Monel metal—or in nickel. Choose the metal that treats your product best—and be sure the high purity of your product is protected all the way to its destination.

Both open head and tight head models are ruggedly built for long life and low damage claims. Both have smooth, crack-free interiors that are easily kept spotlessly clean. Can be furnished as mixing containers without I-bars, cover or clamp ring if desired.

Write for specifications and details. Ask for the new Hackney Drum and Barrel Catalog which describes Hackney engineered containers for all solids and liquids.



## PRESSED STEEL TANK COMPANY

**Manufacturer of Hackney Products** 

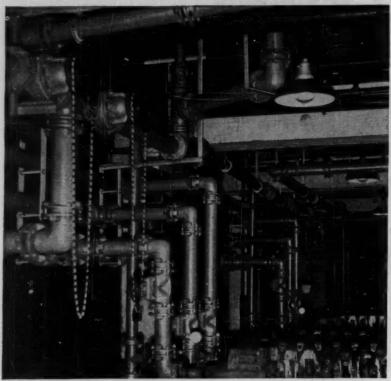
1447 S. 66th St., Milwaukee 14 • 52 Vanderbilt Ave., Room 2025, New York 17
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208 S. LaSalle St., Room 792, Chicago 4 • 553 Roosevelt Bldg., Los Angeles 17
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Hackney

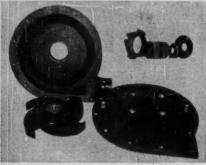
CONTAINERS FOR GASES, LIQUIDS AND SOLIDS

## G EQUIPMENT

· FITTINGS · VALVES



A typical large installation of Haveg pipe, valves and fittings showing simple method of support required. Haveg pipe is unaffected by thermal shock, seldom requires insulation.



These Haveg parts are used in pumps for hot (104°F.) 30% Hydrochloric acid. Typical record: 33 months without replacing a single part. Many users report even longer life.



Escape potential valve troubles by buying Haveg y-valves and diaphragm valves which are smoothmolded, exactingly machined, tested in the Haveg factory. Haveg works with you on special designs!

#### Processing Corrosion has been Controlled!

Where liquids get hot and corrosive, it pays to consider all the facts about Haveg piping systems. Haveg has all the major ingredients for good chemical piping. Strength. Durability. Light weight. Outstanding resistance to corrosion and thermal shock.

It withstands rapid temperature changes and enables you to go into a high range of process temperatures with complete safety and a proven history of reliable performance. Haveg piping resists corrosion of practically all acids (except oxidizing acids) and lasts for years without repairs or maintenance.

Haveg piping is molded in diameters of 1/2" up and comes in lengths to 10'. It can be cut and fitted on the job (a new Haveg tool makes this even simpler-ask your Haveg engineer for details). For handling corrosive gases or fumes,

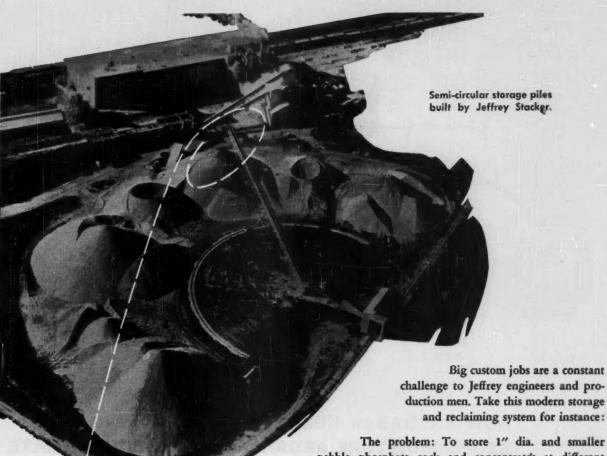
Haveg duct is made in cylindrical or rectangular shape with lighter walls. Fume hoods, bifurcators, fan housings, fittings, all are made from Haveg and give complete containment and control of corrosives.

It's a long story telling all about Haveg, the moldable, thermosetting plastic material made of acid-digested asbestos and synthetic resins. Haveg is both a material and a service . . . it comes from America's first molders of corrosion-resistant plastic equipment. It can be as big as a 200' stack, as small as a miniature pump part. Call the experienced sales engineer listed. Write for the 64-page illustrated Bulletin F-6 which contains size and chemical resistance charts, design specifications. Remember, Haveg is a logical, proven answer to your design problems in handling hot, corrosive liquids; in fact, in all equipment that must control processing corrosion.

CHICAGO 11, Delaware 7-6088 ATLANTA, Exchange 3821 CINCINNATI 36, Sycamore 2600 • CLEVELAND 20, Washington 1-8700 HOUSTON 4, Jackson 6840 DETROIT 39, Kenwood 1-1785 LOS ANGELES 14, Mutual 1105 SEATTLE 7, Hemlock 1351 · WESTFIELD, N. J., Westfield 2-7383



FACTORY: WILMINGTON 8, DEL. . Wilmington 3-8884 A SUSSIDIARY OF CONTINENTAL DIAMOND FIBRE CO.



from top to bottom



Jeffrey Belt Conveyors in tunnels under piles reclaim materials to process.

The problem: To store 1" dia. and smaller pebble phosphate rock and concentrates at different points and reclaim the same material for processing.

The solution: Material is dumped from railroad cars into track hoppers over two Jeffrey-Traylor feeders . . .

moves on Jeffrey Belt Conveyor - at 800 T.P.H. - to track-mounted Jeffrey Stacker which turns on a 270' radius

to build 80-foot-high semi-circular piles of approximately 320,000-ton capacity. A series of valves beneath the piles discharge onto a traveling hopper which feeds two Reclaiming Belts at 336 T.P.H. each for processing. Rock can be removed at controlled rate from any point in pile or several points at once.

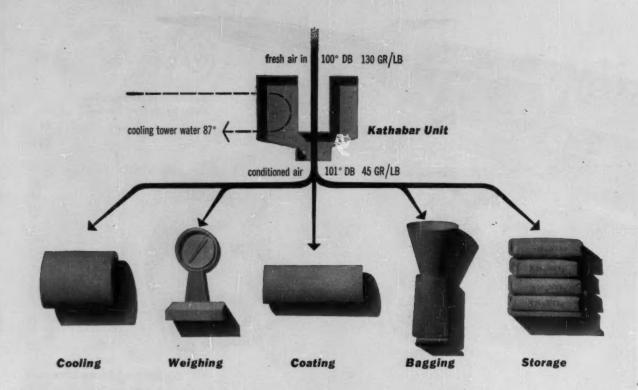
The entire installation is built to withstand hurricane winds . . . to operate efficiently at low cost . . . to meet the rigid engineering standards of Jeffrey and its client. Write for Catalog 852.



IF IT'S MINED, PROCESSED OR MOVED . . . IT'S A JOB FOR JEFFREY!

Columbus 16, Ohio

sales offices and distributors in principal cities



## HOW KATHABAR HUMIDITY CONDITIONING STOPS MOISTURE REGAIN IN AMMONIUM NITRATE

#### using 87°F coolant to get 46°F dewpoint

You can prevent moisture regain in the production of hygroscopic materials—common problem in chemical industries—by taking a cue from major producers of ammonium nitrate. They use Kathabar humidity conditioning to bathe process areas with a protective atmosphere of dry air in equilibrium with their dried prills.

Before they applied Kathabar equipment to this problem, costly recycling was often necessary to restore proper dryness and avoid clogged conveyors and bagging machines, bricking up in storage, inaccurate bagging.

Ammonium nitrate producers selected Kathabar systems to solve these problems because of several operational advantages. Kathabar units are economical; can deliver air at 46°F dewpoint with 87°F cooling tower water. No expensive over-cooling and reheating. They're rugged: perform effectively with only routine maintenance in the extremely corrosive ammonium nitrate atmospheres. They're safe: absorbent solution is non-inflammable, will not carry over.

Kathabar units are doing similar jobs in many other chemical process industries such as pharmaceuticals, plastics, food, rubber, film, atomic energy. They can meet your exacting requirements, too—economically, effectively, safely. Call your Kathabar system engineer or write for Literature Group K54-3 to learn how this equipment can earn for you.



SURFACE COMBUSTION CORPORATION

ALSO MAKERS OF Surface INDUSTRIAL FURNACES

Janterol AUTOMATIC SPACE HEATING

· TOLEDO 1, OHIO



Close to 3 yds. of ammonium sulphite handled by this 21/4-yd. MICHIGAN . . .

## The bonus in the bucket pays for this machine fast!

Take another look at the bucket in the photograph. It shows a typical MICHIGAN\* bucket-load, heaped-up well over the rated capacity of the bucket—nearly a 50% bonus. Translate this bonus into your daily production and you'll see why a MICHIGAN Tractor Shovel pays for itself fast: you simply move more material with a MICHIGAN.

Tremendous digging ability. Get the bucket blade into hard-to-dig material or under a heavy obstacle and "work" the bucket until you've got a heaping load. The two double acting bucket cylinders are actually powerful enough (if the blade is under an immovable object) to pull the back wheels off the ground! We'll match the MICHIGAN'S digging ability against any make

or type of Tractor Shovel, bar

Low-level bucket action. You can roll the bucket back only a few inches off the ground—heaping bucket-loads even when the material is scattered only a few inches high. And you can carry the full load low—your driver can see where he's going, he doesn't have to travel backwards.

No clutch—faster cycles. There's no clutch pedal on a MICHIGAN. You can actually shift between Forward and Reverse while moving: simply push the hand-lever on the steering column—MICHIGAN'S power-shift transmission shifts instantly. Power-shifting saves time and energy every cycle. Your operators will say: "This

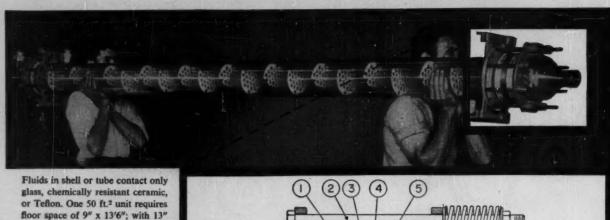
sure beats riding a heavy-duty clutch all day!"

See it in action—on your own job. Write us and we'll arrange a demonstration. MICHIGANS are built to handle jobs too tough for other rubber-tired Tractor Shovels—let us prove it, without obligation. Write for details on the pay-as-you-go MICHIGAN Lease Plan—you can put these machines to work without laying out a penny of capital.

#### CLARK EQUIPMENT COMPANY

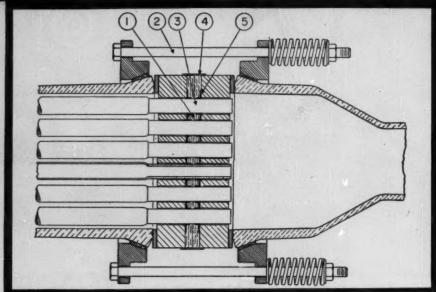
Construction Machinery Division 432 Second Street Benton Harbor 27, Michigan Phone WA 6-6184





of vertical height. Now you can say good-bye to heat exchanger corrosion and contamination problems.

Detail of header assembly for handling corrosion product in both shell and tubes. The unique "fluid" seal between the shell side and the tube side is effected by a Silastic sealer sheet (1). This acts as a fluid and is put under fluid pressure by tightening the flange bolts (2). The fluid is completely contained in the cavity formed by the tubes (3) and the retainer ring (4) around the outside of the tube sheets. The Silastic sealer sheet is compressed against the Teflon sealer sheet protector (5), which presses against the precision finished tube ends, creating a leak-proof seal.



## NEW glass shell and tube heat exchanger gives complete protection from corrosion

Here's real news, if your heat exchangers must handle materials that eat the heart out of metals . . . or chemicals that are sensitive to even slight metallic traces, or fluids that quickly foul the tubes.

The new PYREX brand glass shell and tube heat exchanger offers these seven advantages:

- 1. Complete protection against product contamination and corrosion. No metal parts exposed internally. Use it for all fluids (except those containing hydrofluoric acid, or hot concentrated phosphoric acid, or alkalies).
- 2. Easy Cleaning-The smooth, hard glass is easy to clean. You can see when cleaning is needed-and when it's complete. Can be

- cleaned with hot mineral acids.
- 3. Flexibility-Switch from one product to another quickly and easily. Corrosive material may be used on either shell side or tube side.
- 4. High Efficiency-Light tube walls give a high wall conductivity coefficient (h=260 BTU/hr./ft.2/ Deg. F.). Freedom from deposits keeps efficiency high, no allowance needed for fouling or scal-
- 5. Versatility-Useful for cooling, condensing, heat exchanging and for refluxing or partial condens-
- 6. Compactness-Needs only 9" x 13'6" of floor space and only 13" of height for one 50 ft.2 unit. Stack units vertically in series or

- parallel without additional floor space. And it's so light (only 165 lbs.) two men can handle it easily.
- 7. Economy-The first six features add up to operating economy. But that's just the start! Initial cost is much lower than for most equalcapacity corrosion-resistant shell and tube exchangers. Coolant costs less where you can use sea or river water. Installation is lower. Since glass never wears out, you get long service with no replacement parts worries.

Send for more information—Let us send you more detailed information about this remarkable new PYREX brand glass unit. Just write, wire, or phone Corning Glass Works, 16 Crystal Street, Corning, N. Y.



CORNING GLASS WORKS, Corning, N.Y.

Corning means research in Glass

# Complete "Line-to-Load" Mostrol and Protection

Type H Starters

FOR 2300 TO 5000

FOR 2300 TO 5000

VOLT MOTORS

in ONE Compact Unit

THE Allis-Chalmers Type H high voltage starter is a complete control unit. Everything needed for efficient motor control and positive protection is engineered into one easy-to-install cubicle.

Control functions, varying with specific job applications, include full or reduced-voltage starting, acceleration, speed control, reversing or non-reversing, and dynamic braking.

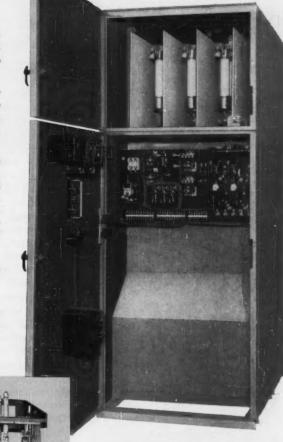
#### A few of the many protective features

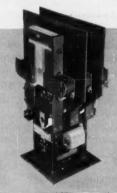
Current-Limiting Fuses clear short circuit in less than ½ cycle...long before short can damage contactor or motor.

Overload Thermal Relay adjusts for ambient temperatures . . . trips only on motor overload. Allows use of maximum capacity.

**Time-Delay Undervoltage Relay** permits restarting if power is restored within its setting.

Compartmented Enclosures isolate high voltages. Dead front construction and electrical interlock on fuse compartment provide additional personnel protection.





Choice of Air or Oil Contactors



For complete information, see your Allis-Chalmers representative, or write Allis-Chalmers, Milwaukee 1, Wisconsin. Ask for Bulletin 1486410B.

A-4580

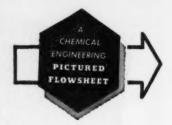
(AC)

**ALLIS-CHALMERS** 

# w Reformer **New Converter New Extractive** Distillation

## **Better Methanol Synthesis**

Extractive distillation, reforming, conversion: important features of this modern plant.



**B**OASTING major improvements in equipment and process, Commercial Solvent Corp.'s plant at Sterlington, La., now produces methanol at a 29 million gal. per year clip, from natural gas.

Just a few years ago the plant produced 15 million gal. per year-but expansion was called for to meet the growing demands for formaldehyde.

Essentially, the expanded plant has (1) a new, more efficient gas reforming system, (2) a new, third converter and (3) a new extraction distillation unit for purifying crude methanol.

▶ Reforming the Gas—Natural gas, under incoming line pressure, flows through sulfur removal vessels containing activated carbon beds. Here organic sulfur and hydrogen sulfide are adsorbed.

The gas is then preheated by heat exchange with hot reformed gas, and mixed with carbon dioxide (CO<sub>2</sub> from adjacent ammonia plant).

Reaction steam (30 psig.) is preheated and mixed with combined natural gas-carbon dioxide streams. This mixture then goes to two parallel reformer furnaces. Reformed gases (CO, CO<sub>2</sub> H<sub>2</sub>) form here, over a nickel catalyst contained in heated vertical, alloy steel tubes. Flue gases are cooled in a waste heat boiler, where 250 psi. steam is generated. After the boiler, flue gases are used to preheat combustion air.

After passing through a steam preheater, a mixed gas preheater, and a natural gas preheater, reformed gases are cooled in a feed water preheater and gas scrubber-cooler. Finally, cool gases enter a gas holder.

► How to Convert to Methanol—From

the holder, gas flows to the first stage of five primary compressors (two new compressors are 2,500 hp., gas-engine driven). Two circulators operating in parallel for each converter system, raise the gases to an operating pressure of 4,800 psig. Each pair of circulators discharges to a common line leading to two oil traps.

The outlet from the oil traps divides into (a) main feed to the top of the converter, (b) a bypass to the bottom and (c) quench lines. These quench lines connect to various points in the converter for close temperature control.

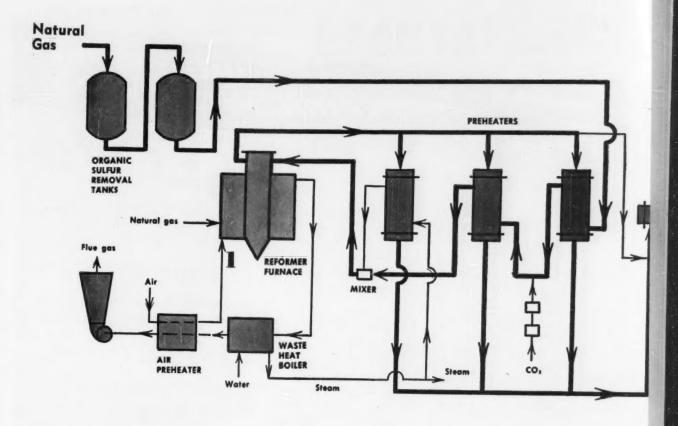
Main flow is downward through the catalyst bed, after passing through an internal heat exchanger. The converter operates at about 5,000 psig. and 400 C. Conversion: about 12 to 15% per pass.

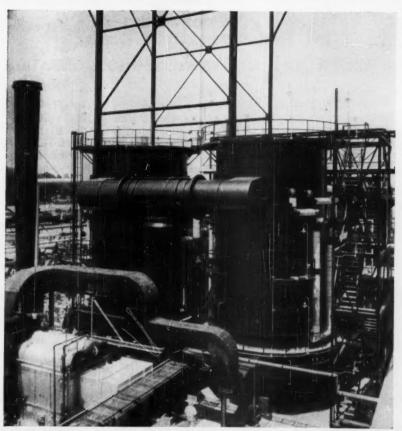
► Extractive Distillation—One of the difficulties involved with refining crude methanol is that impurities (isopropyl isobutyl, alcohol, traces of ethers, ketones and aldehydes) have boiling points close to methanol itself.

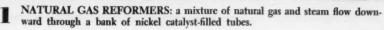
However, Commercial Solvents uses a new extractive distillation unit to accomplish this difficult separation. In the unit, water acts to change the ratio of impurities to methanol in the equilibrium vapor.

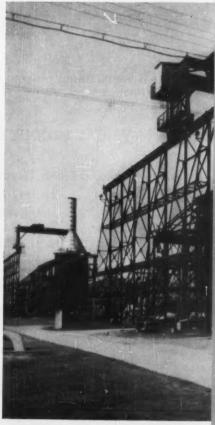
In practice, crude methanol is introduced on plate 25 of the column, soft water goes in on plate 40 (counting from the bottom up). Water flows down the column, and out with methanol.

In a solvent recovery column, water is separated from methanol—which comes off as distillate—and then to storage.

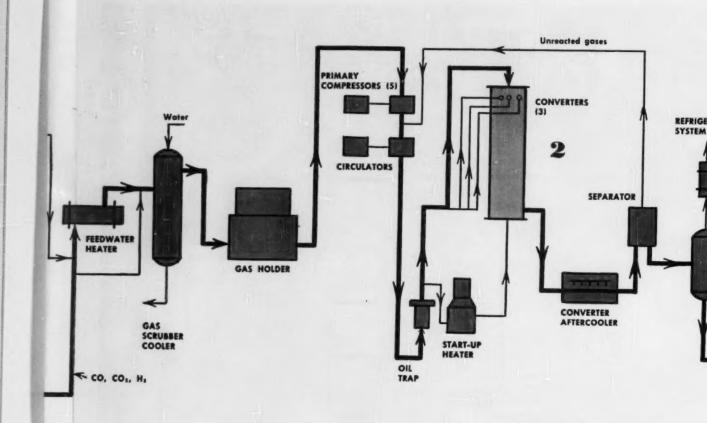


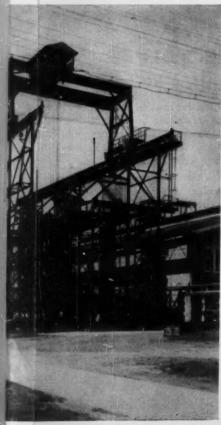




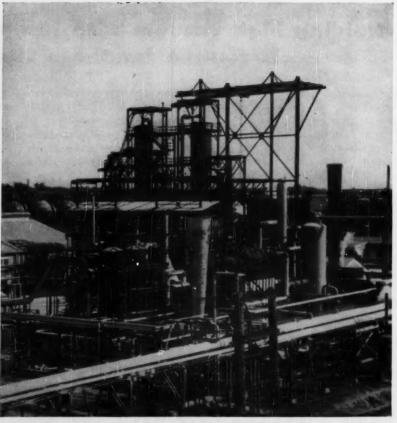


2 METHANOL CONVERTERS, where ( methanol. The overhead crane is for ren

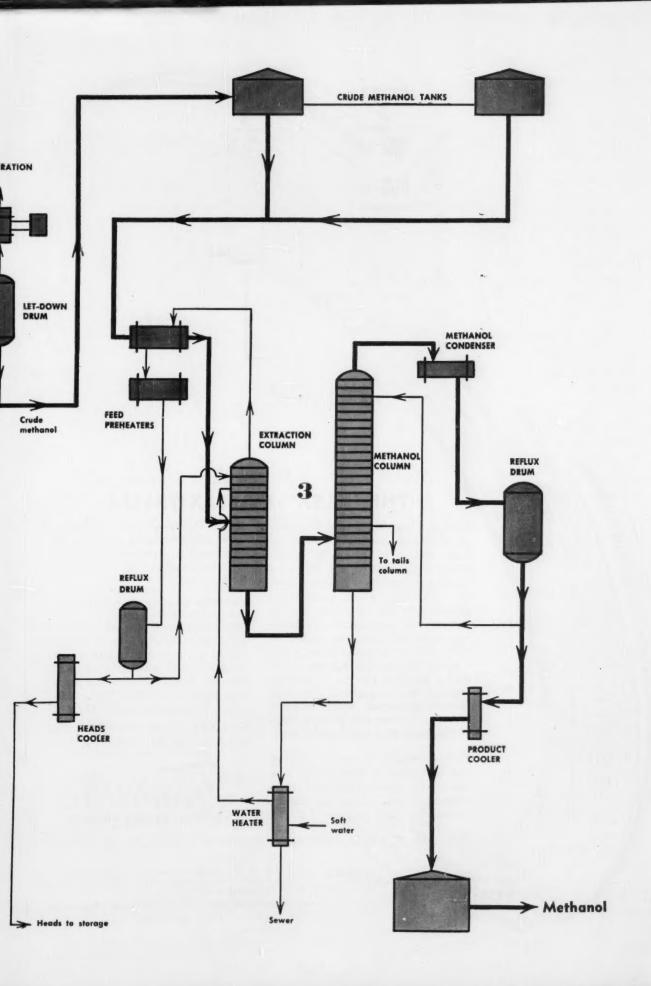


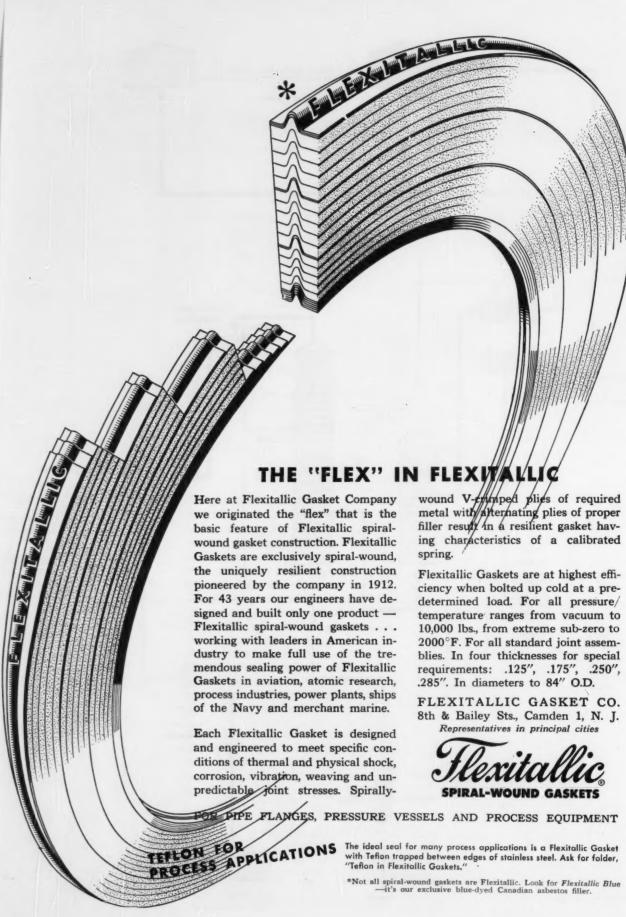


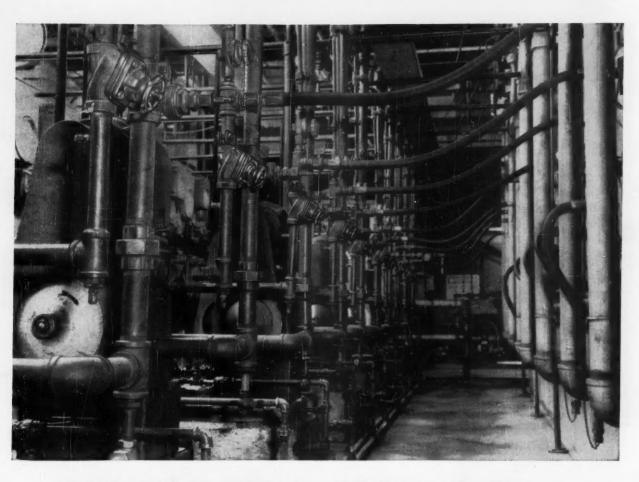
where CO, CO2 and H2 combine to form crude for removal of catalyst bed.



**3** EXTRACTIVE DISTILLATION UNIT—two bubble-cap columns, one for extraction, the other for refining. Water is the extractant here.







## Holding high vacuum with low upkeep is routine for these CRANE VALVES

At the Crosley & Bendix Home Appliance Divs., Avco Mfg. Corp. refrigerator plant at Richmond, Ind., a line vacuum within a few microns of absolute is applied to a dehydration process. But holding this vacuum wasn't always a routine operation.

There was a time when frequent valve failures caused production losses and costly maintenance stopped only when Crane Packless Diaphragm Valves were installed.

Of the valves formerly used, a multiple metal diaphragm type lasted about 3 months. Crowning of diaphragms caused restriction or closure and made the valves inoperable. Damaged diaphragms meant complete valve replacements.

In other valves, in-leakage at the diaphragm-to-stem connection made them unsatisfactory.

Now in service more than a year, none of the Crane Kel-F Diaphragm Valves has needed any maintenance. Crane simplified construction, giving a longer-life diaphragm...tighter bonnet seal and seating...and easier operation...is the reason.

The diaphragm in Crane design has longer life because it seals the bonnet only—is not subject to the cutting and crushing encountered when also used for seating. The separate, positive seating disc controls fluid even should diaphragm fail. Wide selection of body materials and trims. Ask your Crane Representative for Circular AD-1942.

Crane Co., General Offices: 836 S. Michigan Ave., Chicago 5, Ill. Branches and Wholesalers Serving All Industrial



Areas.



## CRANE CO.

VALVES • FITTINGS • PIPE KITCHENS • PLUMBING • HEATING :

CRANE'S FIRST CENTURY...1855-1955

## How RAYMOND ing PRODUCTION OF lash I

Rubarite

A rubberizing material for as-phalts, made by Rubarite, Inc., 141 W. Jackson Blvd., Chicago

#### A SINGLE CONTINUOUS **AUTOMATIC PROCESS** THAT COMBINES —

- drying
- pulverizing
- classifying
- cooling and
- collecting

IN ONE SIMULTANEOUS OPERATION

Flow sheet showing the operating arrange-ment of Raymond Imp Mill with Flash Drying and Cooling System for removal of moisture while pulverizing.

#### TYPICAL PRODUCTS handled by Raymond Flash Drying

CHEMICALS **PIGMENTS** INDUSTRIAL WASTES **FOODS** CLAYS FILTER-PRESS PRODUCTS SYNTHETIC RESINS AND VARIOUS HEAT-SENSITIVE MATERIALS

> If you have a drying-grinding problem on some similar prod-uct — write for recommendations of Raymond engineers.

THE preparation of this modern synthetic material involves delicate handling and close control throughout the process. This was successfully accomplished with the Raymond Flash Drying System since it delivers the finished material in such form that the Rubarite can be easily added to asphaltic hot mixes, so as to disperse rapidly when incorporated in the bitumens, and to retain all of its properties for improving the physical characteristics of asphalt and

During the pulverizing operation, the heated air passing through the mill system effectively removes the moisture, reducing the content from an initial 40% to a final 1% without detriment to the product. At the same time, the material was classified to a uniform powder of required 80-mesh fineness and then air-conveyed to the collector system for cooling and bagging.

The Raymond Flash Drying Mill provides a clean, automatic, dustless system that delivers a consistently uniform product at a record low cost.

STION ENGINEERING, INC.

SALES OFFICES IN
PRINCIPAL CITIE 1311 NORTH BRANCH ST. SALES OFFICES IN PRINCIPAL CITIES CHICAGO 22, ILLINOIS

June 1955—CHEMICAL ENGINEERING



#### Raymond J. F. Kunz: Man of the Month

Career of new executive vice president of the Borden Co.'s Special Products Div. shows the value of varied experience.

"It's surprising how far you can go if you work at it." With that observation Raymond J. F. Kunz, newly appointed vice president of the Borden Co.'s Special Products Div., quietly sums up his varied and successful career.

Though only 47, Ray's already gained success as a teacher, consultant, researcher, engineer and executive. In his new job he'll direct over-all operations in the 10 plants of the Special Products Div. These turn out products ranging from soybean extracts and animal feed supplements to infant foods and pharmaceuticals.

► Gathering Experience — To prepare for his new post, Ray notes that he "spent a lifetime gathering business experience." He started even before he received his bachelor degree, working as a lab assistant and later as a plant chemist while working toward his BS in chemical engineering at night. In

1931, when he graduated from New York's Cooper Union Institute, he had been working as chief chemical engineer in the research laboratory of Electrolux Servel, Inc., for about two years. After graduation, he continued in this post, became an instructor in chemical engineering in Cooper Union's night school and launched work toward his masters degree—all at the same time.

After two years of this ambitious program, Ray left Electrolux to teach full time at Cooper Union. He kept working for his masters at the University of Michigan during summers and received it in 1935. In 1940 he earned his PhD from Columbia. Earlier, in 1934, Cooper Union granted him the professional degree of Chemical Engineer.

► Along the Way – While teaching, he began a private consulting practice and worked on problems

in fields ranging from fuels to foodstuffs. He left Cooper Union in 1941 to serve as consultant, official investigator and, later, director of Division 10 of the National Defense Research Council.

Here, Ray directed confidential government research on chemical warfare agents. He continued in this post through most of the war.

In 1944, he left Division 10 to become director of engineering development at Hoffman-LaRoche, vitamin and pharmaceutical makers of Nutley, N. J.

ers of Nutley, N. J.

To Borden—He joined Borden
the following year to supervise production and engineering in the
special products plants of the company. Elevation to executive vice
president came just last month.

Ray credits this varied experience with giving him the business training needed for a management post. As he sees it: "Since conversion of materials is so important in the profit picture, there's something of a trend to bring engineers into management. But to qualify, the engineer must be conversant with business operations such as sales, accounting, finance, etc."

▶ Get Things Done—"It's also important," he continues, "for the man to be able to work and get things done. He must learn to make decisions and act. Of course, you can never be sure you're right—all business is a risk—but generally, if you don't make a move a competitor will."

With Ray, "getting things done" is not confined just to work. He's had a tremendous number of hobbies. Current fascination is building and operating amateur radio gear. Both he and the oldest of his three sons hold licenses and enjoy swapping experiences with other "hams" the world over.

Prior to radio; he tried his hand at oil painting, and the excellent results of these efforts adorn his office walls. Photography, too, was once a diversion.—HTS

Names in the News continued on p. 378

## HOT SPOT IN HARTFORD!



#### 1575 GALLONS OF OIL NEAR A 1700° FURNACE!

A king-size oil quench is a bad enough fire hazard by itself. Put it next to a roaring, 1700 degree hardening furnace, and it could turn a plant into a cinder pile!

So the Allen Manufacturing Company discovered when they installed this hardening and tempering machine in their Hartford, Connecticut plant!

From the hardening furnace, hexsocket screws are quenched in oil, tempered, then quenched again. A flash fire in the huge oil quenching bath could mean loss of the machine, costly down time—and possible loss of the entire plant!

Safety-minded Allen executives naturally took proper precautions, held the oil far below its flash point with thermostatic temperature controls. Still, they realized that more protection was needed! So Allen called on Kidde-long-time specialists in fire extinguishing systems.

Kidde engineers studied the problem, installed a special carbon dioxide extinguishing system which could be triggered instantly.

If fire strikes, one pull on a control handle pours clouds of fire-killing  $\mathrm{CO}_2$  over the blaze, snuffing flames in seconds. At the same time, pressure-operated switches in the lines automatically shut down feed and conveyor motors!

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NAMES . . .

Bancroft W. Henderson—President of American Synthetic Rubber Corp. For the last 20 years Mr. Henderson headed the rubber chemical sales department of American Cyanamid Co.

Frederick H. Roberts-Appointed director of research for Bakelite Co. with offices in Bloomfield, N. J.

Walter F. Rhoades—General manager of DeSoto Paint and Varnish Co., Garland, Tex.



Joseph W. Lang

Dr. Lang has been named manager of manufacturing for the dyestuff and chemical division of General Aniline & Film Corp. He joined GAF in 1943 after doing research and chemical engineering work for the du Pont company. He was manager of GAF's Rensselaer plant for several years and was made research director in 1952, a post he held until his recent appointment.

Melvin R. Stevinson—Director of research for the dyestuff and chemical division of General Aniline & Film Corp., succeeding Joseph W. Lang.

Charles E. Beaver-Vice president of Research-Cottrell, Inc., manufacturer of electrical precipitation equipment.

Granville M. Read-Recipient of the American Society of Mechanical Engineers Medal. Mr. Read is chief engineer of E. I. du Pont de Nemours & Co., Inc.

Richard A. Mixer-Appointed manager of Metalweld, Inc. MW protective coatings division.

Dwight C. Brown—Senior process engineer in the research and development department of Jones and Laughlin Steel Corp. Mr. Brown has been assigned to work in the fields of coal chemical operations, industrial waste problems and process developments involving lean ore.

H. L. Stockdale—Appointed to the presidency of the Insul-Mastic Corp. of America, supplier of bituminous protective coatings.

William B. McCloskey—Vice president of W. R. Grace & Co., in charge of administrative controls division.

James L. Harvey-Named president of the newly organized Plumb Chemical Corp., an affiliate of Fayette R. Plumb, Inc.

Thomas M. Evans—Recipient of the eleventh annual Parlin Memorial Award for "outstanding contribution to the field of marketing." Mr. Evans is president of the H. K. Porter Co., Inc.

William L. Faith-Vice president of the Air Pollution Foundation, Los Angeles, Calif.

Charles W. Arnold—Recipient of the first Phi Lambda Upsilon National Award, established by the chemical honor society to give early recognition to promising scientists. Mr. Arnold is a research engineer with Humble Oil Co., Houston, Tex.

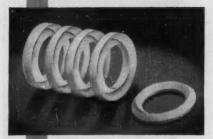
George K. Nelson—Director of the newly-created products development department of Archer-Daniels-Midland Co. Dr. Nelson was formerly with the Celanese Corp. and Shell Development Co.

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won't deteriorate

won't "freeze" shaft action



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#### CUP AND CONE TYPE PACKING

Chemiseal Type 810-W TEFLON Packing for both hand and mechanically operated valves. Cones deform inwardly to effect a seal at the spindle, while cups expand outwardly against stuffing box wall, making possible a tight seal at low gland pressure.



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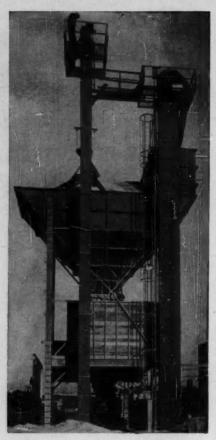
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#### NAMES . . .

Charles A. Thomas-Selected as 1955 winner of the Priestley Medal, highest honor in American chemistry. Dr. Thomas is president of Monsanto Chemical Co.

Philip B. Keller-Vice president in charge of engineering, Stillman Rubber Co., Culver City, Calif.

Frank W. Reinhart – Elected president of the Society of Plastic Engineers. Mr. Reinhart is chief of the organic plastics section of the National Bureau of Standards.



Gordon Kiddoo

Mr. Kiddoo was recently elected vice president-development of the National Research Corp. Associated with the firm for the past four years, Mr. Kiddoo has been director of the development department for three years. He was previously associated with Hydrocarbon Research, Inc., The Texas Co. and the Continental Carbon Co.

Thomas F. Brastow—Promoted to technical consultant to the plant manager at American Viscose Corp.'s Front Royal, Va., plant. Albert G. Ruff, Jr. is asst. manufacturing superintendent at the company's Nitro, W. Va., rayon plant. C. E. Silling, Jr. is product development engineer in the firm's newly created product development section—research and development division.

N. M. Gaboury-Named manager

June 1955—CHEMICAL ENGINEERING

of manufacturing for the organic chemicals division of American Cyanamid Co. F. B. Manker was named manager of the company's Bound Brook, N. J., plant. J. M. Duckett has been appointed manager of the textile resin department, North American Cyanamid Ltd.

George T. Deck-Named plant manager of the new American Lithium Chemicals, Inc., \$6.6 million plant near San Antonio, Tex.

James C. Johnson—Joined the technical service group of Monsanto Chemical Co.'s W. C. Krummrich plant at Monsanto, Ill. He was formerly production superintendent at the company's Norfolk, Va., plant. J. W. Braun is group leader in the research department of Monsanto's plastics division.

Charles M. Herzfeld-Joined the heat and power division of the National Bureau of Standards.

Charles R. Haynes—Associated with National Polychemicals, Inc. after serving with Binney and Smith Co. as manager of rubber technical service. Mr. Haynes was formerly secretary of the Division of Rubber Chemistry, American Chemical Society.

Gerard A. Albert—Manager of manufacturing, National Vulcanized Fibre Co. Henry C. Guhl is the firm's new manager of engineering.

Benjamin S. Collins-Chief development engineer of Nopco Chemical Co.'s plastics division.

A. E. Englebright—President of Pacific Refiners Ltd. in Honolulu, T. H., succeeding E. E. Black, who becomes chairman of the board.

Robert R. Pierce-Elected to the board of directors of the National Association of Corrosion Engineers. Mr. Pierce is sales mana-

## **Helicoid Chemical Gage**

# Gages for corrosive chemicals and liquids up to 5000 p.s.i.

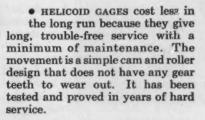
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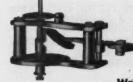
pletely with specific inert liquids and pressure is transmitted directly to the indicating gage through deflection of the sealing diaphragm.



FEATURES

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Clamping Bolt
TEFLON Diaphragm
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Lower Housing





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The ideal Mechanical Seal that has no equal in handling acids, alkalies, solvents, hydrocarbons, alcohols—clear liquids, slurries and tarry materials.

#### FEATURES

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bearing surface is between precision ground rotating and stationary seal faces. Low friction load on shaft. Lower power cost. Drop tight service.

- No scoring of shafts and Chemiseals work satisfactorily on shafts previously scored by other seals or packing.
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NAMES . .

ger of the Pennsylvania Salt Manufacturing Co.'s corrosion engineering products department.

- W. C. Hewitt-Assistant general manager of Phillips Chemical Co., wholly owned subsidiary of Phillips Petroleum Co.
- Julius C. Hydrick—Works manager, Quaker Rubber Corp., division of H. K. Porter Co., Inc.
- Fred B. Doherty-Appointed to the newly created position of general manager of Southeast cellulose manufacturing for Rayonier Inc.
- Ernest Sinclair—Production manager of Robin Pharmacal Corp., Brooklyn, N. Y. Mr. Sinclair was formerly associated with the Vitamin Corp. of America, in charge of all manufacturing operations.



Sheller L. Steinwender

Mr. Steinwender has been appointed vice president of The Permutit Co., New York water conditioning firm. Before joining Permutit, he was vice president of the Scaife Co. in Pittsburgh. Prior to that, he was with A. O. Smith Corp. and American Cyanamid Co.

John P. Longwell—Assistant director of Esso Research and Engineering Co.'s products research division. Maynard S. Northrup and Harold D. Gibson have been named senior engineering associates with the company. Frank A. Faulkinberry-Appointed staff chemical engineer of the Rust Engineering Co., with headquarters in Birmingham, Ala.

Justin H. McCarthy-Vice president of St. Regis Paper Co. Mr. McCarthy was formerly chief engineer of the firm's pulp and paper divisions.



Harold C. Weber

Dr. Weber, professor of chemical engineering at the Massachusetts Institute of Technology, has been named chairman of the Chemical Corps Advisory Council. He joined the advisory group in 1947 and succeeds as chairman Dr. Allan P. Colburn who served with the council from 1950 until his death earlier this year. During World War II, Dr. Weber served as a technical adviser to the Chemical Warfare Service development laboratory. He received the Presidential Certificate of Merit for his work with the Warfare Service from 1941 to 1945. Dr. Weber has been on the staff of MIT since 1920.

Earl Hobein—Plant manager of the Berea Rubber Co., Berea, Kentucky.

B. David Halpern—Research director of the Borden Co.'s chemical division research laboratory at Philadelphia, Pa.

Carl A. von Ende-Appointed to the newly-created position of manager of the Cascade Mill,



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NAMES . . .

paper manufacturing division of Brown Co., Berlin, N. H.

 B. W. Pickard-President of the California Oil Co., succeeding
 E. W. Endter, who resigned.

John O. Parrott-Promoted to general pulp mill superintendent of the Texas division of Champion Paper and Fibre Co.



Hugh C. Land

Mr. Land, affiliated with Pennsylvania Salt Manufacturing Co. since 1946, succeeds William P. Drake as head of the company's industrial chemicals division. As general manager of this major operating division, he will direct both production and sales activities. These include four plants and ten sales offices which produce and distribute a diversified line of heavy chemicals.

Frank J. Soday—Selected as the 1955 Herty Medal Winner for his outstanding contribution to the field of chemistry in the South. Dr. Soday is vice president and director of research and development for Chemstrand Corp. He is also president of the Southern Association of Science and Industry.

Elmer H. Wegner-Vice president of manufacturing of Cleaver-Brooks Co., Milwaukee, Wis.

Richard I. Galland—Elected vice president and general counsel of Colorado Oil & Gas Corp. J. B. Sewell-Vice president of the Garlock Packing Co., Palmyra, N. Y.

George Hampton-Executive vice president of General Foods Corp. Roy H. Walters is director of research and development.

S. A. Swensrud—Elected a director of Goodrich-Gulf Chemicals, Inc., jointly owned company of the B. F. Goodrich Co. and Gulf Oil Corp. Mr. Swensrud succeeds W. G. Moore, retired.

W. K. Robbins—Senior chemical engineer in technical service division at Humble Oil & Refining Co.'s Baytown, Tex., refinery.

George W. Naylor—Appointed a vice president of the chemical division, Koppers Co., Inc. F. L. Byrom is vice president and assistant manager of the company's tar products div. Cooke Bausman, Jr. is assistant vice president of the chemical division.



John C. Jacobs, Jr.

Mr. Jacobs, both an attorney and graduate engineer, has been elected a vice president of Texas Eastern Transmission Corp. In addition to his new executive duties, he will continue as executive vice president and director of Wilcox Trend Gathering System, Inc., a subsidiary of Texas Eastern.

Rex Rainey – Chief engineer for Yale Rubber Manufacturing Co.'s oil seal division.



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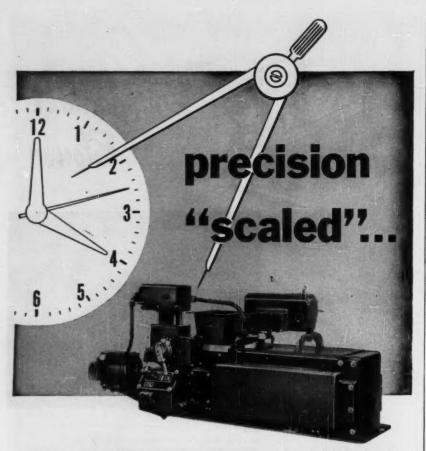
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material and immediately compensates by weight for variations in density, moisture content, etc. Whether feeding ounces or pounds per hour, the pre-set rate of feed is continually and automatically maintained.

If you have a processing problem requiring uniform feeding of dry materials, accurately controlled by weight, communicate with Wallace & Tiernan. You'll receive prompt attention without obligation.

M-21

# WALLACE & TIERNAN COMPANY, INC.

NAMES . . .

Michael G. Kesler-Joined the staff of the gaseous combustion group of Atlantic Research Corp., Alexandria, Va.

Arnold Kramish—Manager of research for the Atomic Industrial Forum, Inc. Mr. Kramish was formerly assistant director of the nuclear energy division of the Rand Corp.

Hamnett P. Munger—Technical adviser at Battelle Institute. He will advise both the Institute and its clients on pilot-plant and large-scale studies in chemistry, metallurgy and related fields.



Ralph Wechsler

Mr. Wechsler is the new president of Nopco Chemical Co., succeeding Thomas A. Printon. Since joining Nopco in 1921, he has served in various capacities, including chief chemist in charge of manufacturing operations and treasurer. Along with this new duties, Mr. Wechsler will act as chief officer of Metasap Chemical Co., a wholly owned subsidiary of Nopco.

Ronald H. Hall—General manager of B. A.-Shawinigan Ltd. Mr. Hall was formerly plant manager of the company's plant in Montreal East.

#### **OBITUARIES**

William Schliemann, for many years a well known figure in the brewing industry, died March 4 at the age of 86. Mr. Schliemann worked in the engineering field for 60 years, before his retirement.

Harry H. Replogle, 77, of the U.S. Dept. of Commerce, died in Washington, D. C., on March 7. He was widely known for the many years he spent in the rubber industry as well as for his affiliation with the Grasselli Chemical Co. and E. I. du Pont de Nemours & Co., Ltd.

Edward A. Robinson, 51, soap and detergent research specialist for Diamond Alkali Co., was killed instantly on March 17 when the car he was driving struck a tree in Willoughby Hills, Ohio.

Newton E. Karish, 32, chemical operator for Rohm & Haas Co., Pasadena, Tex., died March 19.

Francis J. Williams, 47, director of research for the Baroid Division, National Lead Co., died March 19 in Houston, Tex.

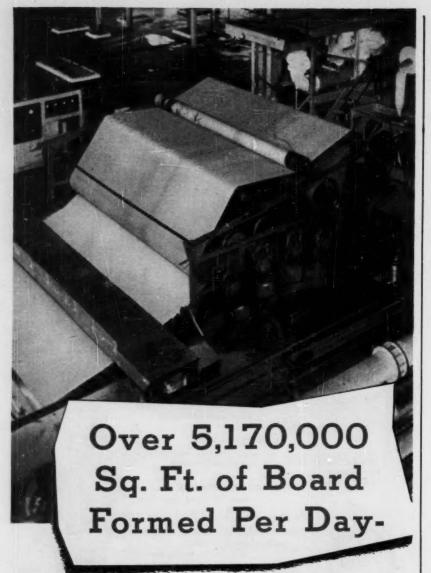
John C. Treacy, 30, assistant professor of chemical engineering at the University of Notre Dame, was killed by an explosion of liquid rocket fuel on March 31.

Edwin P. Johnstone, technical manager of the American Association of Textile Chemists and Colorists Research Laboratories at Lowell Technological Institute, died April 9 at the age of 49. Mr. Johnstone had been in the chemical engineering field for more than 25 years, the last nine with A.A.T.C.C.

John A. Bennett, eastern region office manager of Chas. Pfizer & Co.'s chemical division, died April 10, at his home in Parkchester, N. Y., after a long illness. Mr. Bennett was 51 years old.

W. A. Roberts, president of Allis-Chalmers Manufacturing Co. since February, 1951, died suddenly April 12, following a heart attack. He was 57 years old.





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THIS MONTH'S

#### Technical

#### 12 Years Ago

NOMOGRAPHY AND EMPIRICAL EQUATIONS. By D. S. Davis. Reinhold Publishing Corp., New York. 236 pages. \$6.75.

▶ Paradox—Exactly 12 years ago I reviewed for you this book which was published last month. Before this impossibility is explained, let's see what I told you:

▶ Book Review—"To the readers of contemporary chemical periodicals the name of D. S. Davis needs no introduction. For more than a decade he has been giving nomograms for routine solution of many chemical and engineering equations. Knowing what the author has done in the way of publishing charts for the solution of specific problems will add interest to his treatise giving the know-how. He can give away no trade secrets for there are several books available which cover substantially the same ground. However, Davis, with the aid of completely worked-out examples, probably comes closest to giving understandable directions to readers who are engineers rather than mathematicians.

"The book is in two parts, each of which is mentioned in the title. Chapter I of Part I covers the fundamental forms of empirical equations. The desirability of expressing experimental data in the form of an equation is obvious. This chapter gives step-by-step directions for taking results plotted on regular coordinate paper and converting them into one of the 10 types of equations. Chapters II and III of this section cover special methods for two and three-variable correlation.

"It is Part II which covers nomography—the theory and construction of alignment and line coordinate charts. All of the various types are discussed: addition charts, logarithmic charts, recurrent variable charts, nonlogarithmetic multiplication charts, combination charts and line coordinate

charts. Here again the author has selected a typical example for each type, worked through the calculations necessary for the construction and presented them together with the completed nomograph.

"There probably are some chemical engineers and chemists whose interest in empirical equations has extended only to curiosity as to how they were derived, and whose appreciation of nomographs is only for the ease with which routine calculations may be handled. They might like to find their personal problems solved for them in this book. That, however, will come only with work and understanding. Davis leads the way quite competently."

► Explanation—The above review which you read 12 years ago was written for "Empirical Equations and Nomography." All comments apply to the book under consideration today: "Nomography and Empirical Equations." The difference between the two books is about as significant as the difference in titles.

Obvious differences include (a)

#### Recent Books Received

Aluminum Paint and Powder, By J. D. Edwards & R. I. Wray. Reinhold. \$4.50.

Electrons, Atoms, Metals and Alloys. By William Hume-Rothery. Louis Cassier Co. \$10.

Experiments in Organic Chemistry. By L. F. Fieser. Heath. \$5.25.

Methods of Quantitative Micro-Analysis. 2nd ed. Ed. by R. F. Milton &

W. A. Waters. St. Martin's. \$15. Organic Solvents. 2nd ed. Revised by . A. Riddick & E. E. Toops, Jr. Interscience. \$8.50.

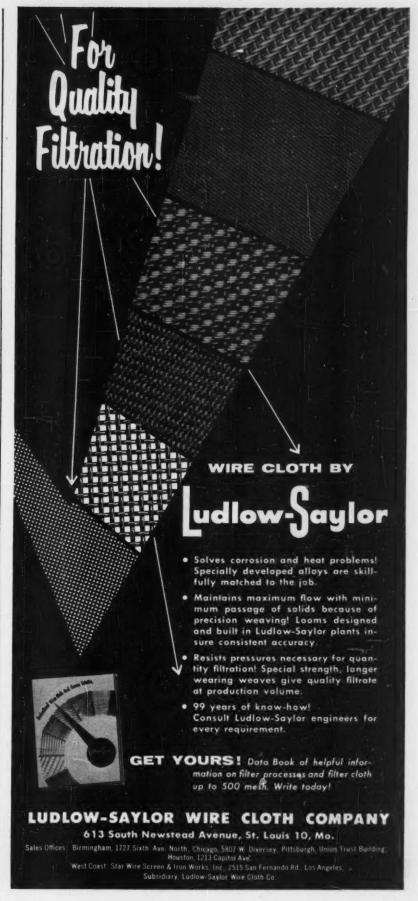
Physical Chemistry. By F. Daniels & R. A. Alberty. Wiley. \$6.50.

Principles of Emulsion Technology. By P. Becher. Reinhold. \$2.95.

Protective Coatings for Metals. 2nd ed. By R. M. Burns & W. W. Bradley.

Reinhold. \$12. Spontaneous Ignition of Liquid Fuels. By B. P. Mullins. Butterworth, London. \$2.75.

X-Ray Diffraction by Polycrystalline Materials. Ed by H. S. Peiser, H. P. Rooksby & A. J. C. Wilson, Institute of Physics, London. 63s.



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synonymous term with our engineering staff because practically every member of our design group has had years of experience with the many variations in this widely used processing step.

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Illustrated here are two distinct types of trays, each different in design and functioning, each subject to modifications to meet special conditions. We shall be glad to send you full details on any and all types. If in requesting this information, you will outline your requirements, we could perhaps at the same time suggest the best type for your operations.

In all our processing equipment—standard or special or made to order—we focus the knowledge and experience of our engineers on the design details and end use. We feel that this engineering service is an essential part of our manufacturing service which covers a wide range of processing equipment, particularly in the fields of distillation, absorption, crystallization, solvent recovery and purification, extraction and similar operations.

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#### BOOKS . . .

many instances of slight rewording of the old text, (b) an 84% increase in the number of problems, (c) a new chapter on graphical anamorphosis replaces one on special slide rules, (d) old Chapter I is divided into new Chapters I and II, (e) a 170% increase in price.

Obvious similarities are many illustrations made from the old book, problems, and sequence of the topics discussed.

Obvious reason for the switch in title: a new publisher has produced what would normally be a revised edition for the original publisher. Less obvious is the reason why the author and publisher used a title which had already been taken by another author and publisher.

Let's be fair. Let's not indulge in damning faint praise. In truth, Davis' first edition is out of print, his new edition is a must for all nomographers — present and future—who do not have a copy of one or the other.—LBP

#### **Authoritative Reference**

TURBOBLOWERS. By A. J. Stepanoff. John Wiley & Sons, New York. 377 pages. \$8.

In chemical plants and petroleum refineries more pumping jobs are being turned over to centrifugals. Engineers are finding more applications for turbomachinery when compressing gases and vapors. And they're using bigger units with higher pressure ratios in single casings. Horsepower and efficiency are up calling for more careful and competitive design

Normally this is a field for our mechanical engineering brethren. But if you work around centrifugal blowers in your area of the plant or you are working with fluid flow theory or the design of flow equipment, you'll want to refer to this new book by Dr. Stepanoff.

He has accumulated in this one volume extensive experience from several related fields. Knowledge available from the centrifugal pump field is profitably applied to blower design.

For the thermodynamicists among us, you'll find it especially useful to read through the discussion of the "available energy" concept starting on p. 97. It is Stepanoff's firm conviction that the thermodynamic aspects of compression of gases cannot be adequately treated without a thorough understanding of available energy.

But this book certainly is not all theory. You'll find in it a considerable discussion of practical applications, usable design methods and a review of the art of building turbocompressors both in the United States and abroad—RFF

#### Hardly No More

INORGANIC CHEMISTRY.
Sixth edition. By Fritz
Ephraim. Edited by P. C.
L. Thorne and E. R. Roberts. Interscience Publishers, New York. 956 pages.
\$6.25.

Reviewed by F. C. Nachod

This could almost be called "Ephraim revisited." This reviewer did not think that when he commented about ten years ago (in what then was Chem & Met) in January of 1945 to be exact, on the 4th edition of this fine book, that he would be privileged to do so again on the occasion of the 6th revised edition.

We liked the book in 1945, of course even better in its new appearance. One of the most amazing things though is that this text which grew in volume by 35 pages, which contains new subject matter (orbitals, resonance, transuranium elements) and which is printed on good postwar paper is actually cheaper by \$2.50 than its older edition. Truly, this is an unprecedented book bargain in these days of mounting prices!

It has already been mentioned that much new material is added and it should be stated that this is not restricted to the 3% volume increase. To quote the editors in their preface—"The small net in-

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BOOKS . . .

crease in size of the book—some seventeen pages on the last edition—has been made possible by skillful replacement of old by new matter made available since the last edition."

Much history has been made in these intervening years, and much of it can be found in the present edition. And perhaps the reader will feel a certain amount of nostalgia if he finds this passage in the 1944 edition—". . . about thirteen different half-life periods had been recognized by early 1940; some of these were allotted to the various 'transuranic elements'."

Now, for example on page 100, the Manhattan District's work is well represented in a list of the valences of six transuranium elements!

Many other evidences of careful editorial work is in appearance. This text recommends itself and needs no boost on the part of the reviewer. As was already indicated above, one can hardly afford to be without it or "they don't hardly ever write "Inorganic Chemistry" compendia like this no more."

#### Statistical Tools

STATISTICAL ANALYSIS IN CHEMISTRY AND THE CHEMICAL INDUSTRY. By C. A. Bennett and N. L. Franklin. John Wiley and Sons, New York. 724 pages. \$8.

Reviewed by J. K. Borland

It has only been in recent years that chemists have acknowledged the proper place of statistical methods in their professional activities. A majority of experienced chemists did not study these methods as part of their formal training. Attention and interest were aroused by technical meetings and publications on practical applications.

The authors have assembled methods of special interest to the chemist and chemical engineer. Statistical tools are described, theory and mathematical proofs are given, and arithmetic examples are worked out. The examples of applications are taken from chemical

and allied industries. Persons familiar with elementary statistical notions will find the book immediately useful. Others may receive their introduction to the subject through this book.

A list of 128 selected references is given to supplement discussion of special topics. Tabulations of many useful functions and distributions are given. One could wish for a more extensive index.

This book deserves a prominent place on the crowded shelf of new books on statistical methods.

#### Parallelism

GLASS REINFORCED PLASTICS. Edited by Phillip Morgan. Iliffe & Sons, Ltd., London. Philosophical Library, New York. 248 pages. \$10.

Reviewed by C. L. Mantell

This is a British book on a currently important and growing subject. The editor of the volume is also the editor of "British Plastics." In his preface he states that "no attempt was made to correlate the various test figures. As a result the different chapters, each written by a different author, may be in disagreement." In the present rapid growth of the art, this, perhaps, is unavoidable but in a collated book it should be at a minimum. Unconsciously a comparison will be made with "Fiberglass Reinforced Plastics" by Sonneborn of the Technical Service Department of Owens Corning, published by Reinhold last year. In comparison the English volume is rambling and not concise or co-ordinated.

The first chapter covers glass fiber forms and properties but the next five are on the chemistry of polyester, allyl, phenolic, silicone, melamine, epoxide and furane resins, as well as ancillary materials but with little discussion on the engineering aspects, molding temperatures and quantitative data. Succeeding chapters devote their attention to commercial moulding practices, methods of mass production, tube and rod formation.

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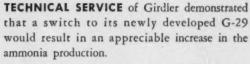
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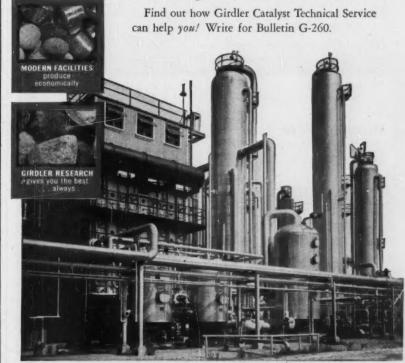


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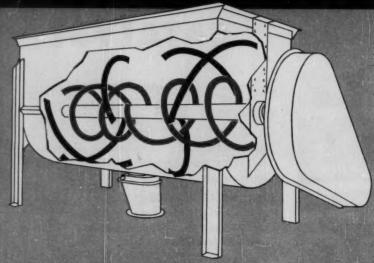


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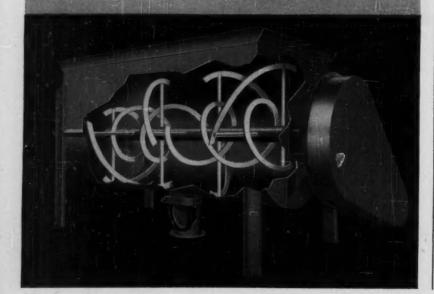
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#### BOOKS . . .

Succeeding chapters cover design, applications in aircraft, electrical transport, marine and boatbuilding, and miscellaneous employment of reinforced plastics.

The volume is an interesting addition to the literature of a rapidly growing field. It indicates a surprisingly close parallelism with the development of this field in the United States and in Great Britain. There are so many new angles and approaches to the subject that it is hardly to be hoped at this stage that there will be critical evaluation of the fiberglass reinforced plastics.

The volume will be an interesting addition to the libraries of those working in this growing area.

#### Electrolytic Processing

DIE TECHNISCHE ELEKTROLYSE DER NICHTMETALLE. (Industrial electrolysis of non-metals.) By J. Billiter. Published by Springer Verlag, Vienna. 400 pages. \$16.40.

Reviewed by M. Wulfing-hoff

In the field of electrolytic processing from aqueous solutions, numerous developments have taken place during these last decades. Professor Billiter's unique qualification for authoring a treatise on this subject rests on the fact that his own activities are closely connected with that field and coincide with that period.

The first part of the book deals with the electrolysis of alkalis, oxygen acids and their salts, the production of hydrogen and oxygen, electrolytic oxidation and reduction, the manufacture of per compounds, and sodium sulfate electrolysis. Points covered incidentally include the fundamentals of electro-osmosis, electrodialysis, selective diaphragms, and isotope separation.

The second part is devoted to the electrolysis of halogen compounds, particularly that of alkali chlorides, with brief reviews of hypochlorite, chlorate, perchlorate, and chlorite processes. Special stress is being laid on methods and equipment which have economic significance under present condi-

Students and inorganic chemists will find this treatise a valuable source of information, as will chemical engineers, project engineers and equipment designers.

The drawings are clear, the halftones well selected, and the typography is excellent.

#### **Metallurgical Conversations**

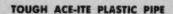
ELECTRONS, ATOMS, MET-ALS AND ALLOYS. Second edition. By William Hume-Rothery. Philosophical Library, New York. 387 pages. \$10.

Reviewed by J. M. Denney

The discussion of electron theory of metals is conducted in a qualitative fashion at the introductory level. The reader is assumed to have only a slight acquaintance with quantum mechanics and those features of modern physics basic to metal physics. This second edition is enlarged and revised, but still presents the discussion throughout in conversational form between an "Older Metallurgist" and a "Young Scientist." The novel presentation is concerned with a description of atomic physics (Part I) before discussing the theory of metals (Part II) and alloys (Part III). A brief discussion of nuclear structure is given also (Part IV).

The discussion is typical of the electron theories pertaining to physical metallurgy for which Hume-Rothery is well known. The presentation of this material in the unique and charming conversational style between the "Older Metallurgist" and "Young Scientists" will undoubtedly appeal to those engineers who might otherwise find a text of the subject tedious. The engineer desiring to acquire a qualitative understanding of modern alloy theory without wishing to bother with the quantitative detail will find this text well recommended.





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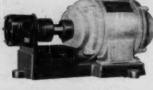
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#### THIS MONTH'S

# Recent Books

## Northwestern Economy

Cheap energy is one of the key factors in development of the chemical and process industries in the Pacific Northwest. Accordingly, this regional analysis of supply, utilization and cost of energy will be of prime interest to present and future northwestern manufacturers. (282 pages)

> "Energy Base of the Pacific Northwest." By E. J. Kolde. Bureau of Business Research, University of Washington, Seattle, Wash. \$5.

#### **ASTM Publications**

Interpretation of Engineering Data—The 1954 Edward Marburg lecture in which Harold F. Dodge discusses quality engineering and quality control techniques. (36 pages \$1.50.)

1954 Supplement to the Metal Cleaning Bibliographical Abstracts -Brings up to date the coverage by this bibliography of the published data on metal cleaning. 227 new references. (48 pages, \$1.50.)

Symposium on Radioactivity-An Introduction-Symposium held to call attention to the possible utilization of radioactive isotopes in testing. Six papers plus a foreword and introduction. (54 pages, \$1.75.)

Standards on Paint, Varnish and Related Products-Ninth edition providing in convenient form more than 200 specifications, tests and definitions. (868 pages, \$6.)

Standards on Rubber Products-Special compilation gives in compact form the widely-used methods of test and specifications developed by ASTM Committee D-11. (684 pages, \$5.50.)

Standards on Petroleum Products and Lubricants-1955 edition giving in latest approved form more than 100 test methods, numerous specifications, and lists of definitions of terms. Appendixes cover proposed tests of jet fuels, steam turbine oils and aviation fuels. (980 pages, \$6.65.)

# & Pamphlets

Standards on Mineral Aggregates, Concrete, and Nonbituminous Highway Materials-Includes 28 specifications and test methods adopted in 1954. (352 pages, \$3.50.)

> American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa.

### Organic Syntheses

Ten of the annual volumes (Vols. 20-29) have been revised, modernized, modified and improved. 890 pages.

> "Organic Syntheses, Collective Vol. III." Edited by E. C. Hornung. John Wiley & Sons, 440 Fourth Ave., New York 16, N. Y. \$15.

## Lab Standards

Current information on more than 600 reagent chemicals and standards-maximum limits of impurities and the methods of detecting and estimating them. 561 pages.

> "Reagent Chemicals and Standards." 3rd edition. By Joseph Rosin. D. Van Nostrand Co., 250 Fourth Ave., New York, N. Y. \$9.50.

#### Math

Advanced textbook for engineering students which will introduce topics pertinent to their fields. Ordinary differential equations through operational calculus. 548 pages.

> "Advanced Mathematics for Engineers." 3rd edition. By H. W. Reddick. John Wiley & Sons, 440 Fourth Ave., New York 16, N. Y. \$6.50.

#### Electronic Processes

A new electronics industry is emerging based on semiconducting and luminescent materials. The need for an annual collection of abstracts is obvious. This book is the first. Compiled at Battelle Memorial Institute and sponsored



rubber casing and impeller, Hastelloy C shaft. Handles nearly all corrosives. Mechanically simple, trouble-free. Bulletin CE-55. Larger ACE pumps available.

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#### PAMPHLETS . . .

by The Electrochemical Society. 169 pages.

"Abstracts of the Literature on Semiconducting and Luminescent Materials and Their Applications." John Wiley & Sons, 440 Fourth Ave., New York 16, N. Y. \$5.

#### Ozone

Second of a series on ozone technology, this reference contains unpublished research as well as 577 references and abstracts covering physical and pharmacological properties. 192 pages.

"Bibliography of Ozone Technology, Vol. II." Armour Research Foundation, Illinois Institute of Technology, 10 West 35 St., Chicago 16, Ill. \$6.25.

### Enzymes

An introduction to and a textbook for study of the "living" molecules so important to industries such as meat, beer and tobacco. An attempt to bring into focus the entire field of enzyme chemistry. 315 pages.

"Outlines of Enzyme Chemistry." By J. B. Neilands and P. K. Stumpf. John Wiley & Sons, 440 Fourth Ave., New York 16, N. Y. \$6.50.

#### Arizona

Some of the latent wealth of Arizona comes to light. This survey reports the nonmetallic resources, tabulated by counties with descriptive material of a general nature for each substance. 85 pages.

"Arizona Development Board Report on Selected Natural Resources." Arizona Research Consulants, 917 W. Hatcher Road, Phoenix, Ariz. Gratis.

#### Magnesia Insulation

A revised second edition offers new conductivity, density and fireresistance data for 85% magnesia insulation. The new water-resistant magnesia insulation is described. Heat loss tables have been recalculated because of adoption of "simplified thicknesses" and lower conductivity of the modern product.

"85% Magnesia Insulation Manual." The Magnesia Insulation Manufacturers Association, 1317 F St., Washington 4, D. C.

#### Steam

Here's the thirty-seventh edition of a text you first met in college—the B & W book on steam. From sources of heat energy through nuclear power, this well-known reference contains the latest and best information on the production and use of steam.

"Steam, Its Generation and Use." The Babcock & Wilcox Co., 161 East 42 St., New York 17, N. Y. \$10.

#### Economic Welfare

Six Brookings lecturers discuss economics and its application to policy problems. They are examining the usefulness and limitations of economic theory for the guidance of policy. 157 pages.

"Economics and Public Policy." The Brookings Institution, 722 Jackson Pl., N.W., Washington 6, D. C. \$2.

#### Handbook

Here's the fourth edition of the Permutit handbook of detailed information on the various processes and types of equipment used for the conditioning of water.

"Water Conditioning Handbook." The Permutit Co., 330 West 42 St., New York 36, N. Y.

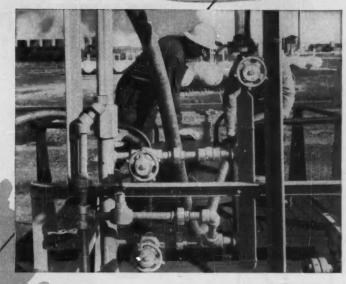
### **Publications**

The first comprehensive annual listing of publications from the the Masachusetts Institute of Technology lists more than 1,100 titles written by M.I.T. faculty and staff during the year ending July 1, 1954. 80 pages.

"Publications From the Institute 1954." Office of Publications, Massachusetts Institute of Technology, Cambridge 39, Mass. 50¢.

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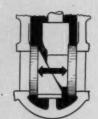


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THIS MONTH'S

# Firms in

## New Representatives

Alloy Precision Castings Co., Cleveland, has appointed Hopper & Son as exclusive sales representatives in western Pa., northern W. Va. and southeastern Ohio.

Ampco Metal, Inc., resistance welding division, Milwaukee, has selected General Distributing Co., Great Falls, Mont., as exclusive distributor for Ampco-Weld electrodes and alloys in Montana. Ampco's safety tool division has appointed Aviation Service Supply Co., Kansas City, Mo., and Ogden, Utah, and Amco Corp., Linden, N. J., as distributors of Ampco spark-resisting hand tools.

Atlas Valve Co., Newark, N. J., has selected Stanley M. Proctor Co., Cleveland, as exclusive representative in the Ohio area.

Beryllium Corp., Reading, Pa., has named Chas. A. Strelinger Co., Detroit, Mich., as warehouse distributor for Berylco nonsparking safety tools.

Childers Manufacturing Co.,
Houston, has named John P.
Dobbins Co., Tulsa, Okla., D.
M. Allen Co., Kansas City, Mo.,
Pace-Turpin Co., Salt Lake City,
Utah, Fred G. Greaves Co.,
Seattle, Wash., as engineering
representatives for its aluminum
weather-proof jacketing.

Cleaver-Brooks Co. has named the Delval Equipment Corp., Philadelphia, as manufacturers' representative for the sale of its boilers and equipment.

National Aniline Div., Allied Chemical & Dye Corp., has named Fuller & Smith & Ross, of New York, to handle advertising and promotion for an important new textile fiber, a deepdye nylon. M. A. Gibbons

Cooper Alloy Corp. has appointed the Cameron & Barkley Co. as distributor for its stainless steel valves, fittings and accessories.

Bulkley, Dunton Processes Inc. has named H. E. Danby Co., Inc., Indianapolis, Ind., Nicholas A. D'Arcy, Jr., Huntington Park, Calif., W. H. Davidson Co., Wayne, Pa., and John D. Homan, Tampa, Fla., as sales agents and representatives.

Electric Regulator Corp., Norwalk, Conn., has appointed H. M. Richardson & Co., Minneapolis, as sales representative in N. D., S. D., Minn. and northern Wis. E. L. Berman Co. is sales representative in northern Calif. and part of Nev.

Hammel-Dahl Co., Providence, R. I., has selected Russell F. Clark Co., Pittsburgh, Pa., as sales and service representative.

Metalab has appointed the five eastern warehouses of Will Corp. and its subsidiaries as distributors of its complete line of SD-3 sectional laboratory furniture.

Sarco Co., Inc. has announced that Hoffman & Hoffman Co. succeeds Royster H. Johnson Co. as its sales representative in N. C. and S. C.

Parker Appliance Co., Cleveland, O., has appointed Hope Rubber Co., Inc., as distributor for its tube fittings.

Young Machinery Co., Muncy, Pa., has named the Syntron Co. as sales representative for its Transvair pneumatic conveying systems.

Rhodia, Inc., New York, has named Holly Chemical Co., Mount Holly, N. J., as engineering representative for the municipal wastes and agricultural and



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#### New Lines

Eastern Industries, Inc. has entered the plastic laminates field. A new affiliate, New England Laminates Co., Inc., will manufacture laminates for the electrical and electronic industries.

Max Factor & Co., Hollywood,
...Calif., is forming a pharmaceutical division for manufacture
and distribution of pharmaceutical products outside the cosmetics field.

#### New Companies

Brazilian Styrene Co., organized by Koppers Co., Inc., Firestone Tire & Rubber Co. and Brazilian interests, will construct and operate a styrene monomer plant at Cubatao, Brazil.

Dwight-Lloyd Div., McDowell Co., Inc., has been organized upon the acquisition of the entire assets and research facilities of Sintering Machinery Corp., Netcong, N. J.

International Resources Engineering and Exploration Group (IREX) has been formed by pooling the facilities of three organization—Brown & Blauvelt, Jack Aman Photogrammetric Engineers and Texas and Geophoto Services.

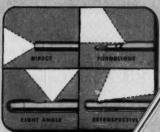
Pennsylvania Fluoro Plastics Co. will manufacture thin- and heavy-walled Teflon tubing.

Litwin Engineering Co., Wichita, Kan., has been organized to design and construct refineries, gasoline and petrochemical plants.

Associated Chemical Engineers, a consulting partnership, has been organized by five Carnegie Tech chemical engineering professors—R. B. Beckman, L. N. Canjar, R. R. Rothfus, H. L. Toor and D. H. Archer.

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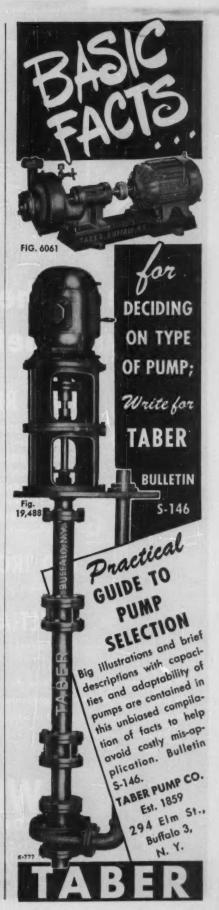


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58

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"1000" SERIES REDS

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Whenever red is the question, be sure to see your Williams representative. Meanwhile, send today for complete technical information.

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#### FIRMS . . .

Grange Chemicals, Ltd., a new company to manufacture alkane, a detergent ingredient, has been formed by three companies—Oronite Chemical Co., British Petroleum Chemicals, Ltd. and British Petroleum Co., Ltd. The company is expected to begin operations by late 1955, on completion of its multi-million dollar plant at Grangemouth, England.

#### New Names

Michigan Panelyte Molded Plastics, Inc., is the new name of Michigan Molded Plastics, Inc., 100% of whose cap.tal stock has been acquired by St. Regis Paper Co.

#### New Locations

Dresser Industries, Inc. has moved its headquarters to the Republic National Bank Building, Dallas, Tex.

Atlas Powder Co.'s sales headquarters for its Darco activated carbons has been transferred from New York to Wilmington, Del.

Van Pell Chemical Supply Co. is now located at 50 Bond Street in New York City.

Shell Chemical Corp's agricultural chemicals division will move its headquarters from Denver, Colo. to New York City.

Fritzsche Brothers of Canada, Ltd., an affiliate of Fritzsche Brothers Inc., has opened a new Canadian office in Montreal. Can.

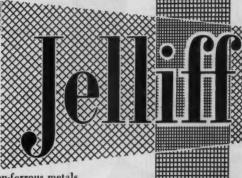
Midwest Research Institute has removed its offices and laboratories to its new building on Volker Blvd., Kansas City, Mo.

Jervis B. Webb Co. has moved into 5,000 sq. ft. of new office area in its factory building in South Gate, Calif.

Gallowhur Chemical Corp. has moved its New York office to the



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Ertel asbestos sheets are available in ten uniform grades for all filters up to 25" square. Manufactured under rigid control, they are acid treated to meet Ertel standards of low leachable calcium and iron content. Sheets are checked constantly by a reputable analytical laboratory. . Copies of their reports are available.

If you are not already a user of Ertel sheets, try
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will test filter your product at no
charge in our laboratory in order
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Many industries have found that this chemical of hundreds of uses can be efficiently and economically used in various production processes. Perhaps Tennessee's highest grade Liquid Sulfur Dioxide can be utilized to great advantage n your processing.

e would be pleased to discuss versatile product with you.

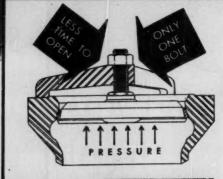


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SILLERS FLEX RING CLOSURES give you many advantages and economies over the conventional flange type of closure, making the Sillers Closures about the most outstanding closure for the industry. LOW INITIAL COST . LESS TIME FOR OPENING AND CLOSING (JUST ONE BOLT) . . . TIGHTER SEALS AT HIGH PRESSURES ... LESS WEIGHT ... EASE OF HANDLING . . . and NO SEAL DESTRUCTION IN CASE OF FIRE, are just a few of the many advantages and features of the SILLERS FLEX RING CLOSURES. Sillers Closures are available in all standard sizes and can quickly be adapted for special applications.

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Division of Peerless Manufacturing Co. BOX 13165 DALLAS, TEXAS

Representatives in Principal Cities

(1). Flex Ring Unit assembled as in service. (2). Spider released, gasket being removed. (3). After gasket is removed, plug is rotated to open. (4). Unit completely opened and in a fraction of time taken for conventional type closures.

#### FIRMS .

Ossining N. Y. plant and laboratory site.

Raycon Corp. has moved from its old location in Redwood City into a new building in Belmont, Calif.

Precision Chemical Pump Corp., formerly Precision Machine Co. of Somerville, Mass., has moved into new offices and plant in Waltham, Mass.

Norton Co.'s Los Angeles district office has moved from South Alameda St., Los Angeles, to Pacific Blvd., Huntington Park,

Braun Corp., Los Angeles, Calif., will move its warehouse operations into a new building in East Los Angeles in July.

Dorr-Oliver Inc. has announced the relocation of its Chicago office in Merchandise Mart and the opening of a new office in the Midland Building, Cleveland, O.

U. S. Industries, Inc. has relocated its New York and Chicago executive offices at 250 Park Ave., New York City.

Union Asbestos & Rubber Co.'s fibrous products division's sales department has moved from the company's Chicago headquarters to a new building next to the Bloomington, Ill., plant.

Insul-Mastic Corp. of America has transferred its home office from Pittsburgh, Pa. to the office building of its plant in Summit,

#### New Facilities

Caja de Credito Agario, Industrial, y Minero de Colombia, quasi-official Colombian bank, is sponsoring the first laboratory center in Bogota, Colombia, devoted specifically to technological research. Armour Research Foundation will be technical adviser on the project.

# Fights CORROSION HARD

ALPHA 101 AND 103 - Rigid PVC Plastic Pipe

#### Recommended for 3 out of 4 **Chemical Lines**

Good at licking corrosive problems. Mighty good for its perfect resistance to hydrochloric . . sulphuric . . nitric acid and more than 186 commonly used chemical corrosives - at lower

used chemical corrosives — at lower temperatures and pressures. When the right PVC Pipe handles your fluid lines you solve corrosion problems permanently! That's why ALPHA 101 Normal Impact Unplasticized Streight PVC

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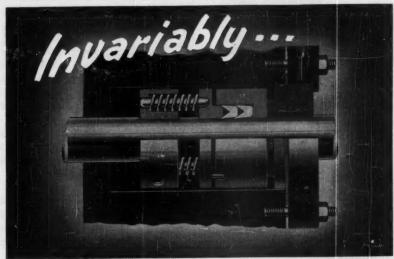
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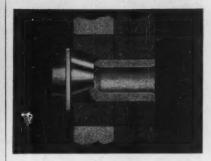
WRITE FOR BULLETIN 455-CE

DURAMETALLIC SEAL KALAMAZOO

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# WHY

'Surface' burners improve heating processes



Tunnel burners, single or twin-nozzled, assure you of complete and rapid combustion within the tunnel.

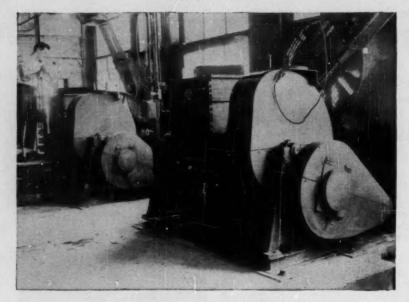
Thousands of 'Surface' burners, in the chemical industries, have speeded up and improved many heating processes because they:

- 7 Save fuel with automatic propor-
- 2 Simplify control equipment with one-valve operation.
- 3 Increase the range of operating temperatures with high turndown ratio.
- 4 Increase safety with a design which mixes gas and air at or near the burner—explosive mixtures piped very short distances.
- 5 Save time in adjustment with easyto-change spuds and inserts.

Select the right equipment from 80 types and 800 sizes completely described and rated in the 'Surface' catalog. Stop waste and start savings soon -call your 'Surface' engineer or write for Literature H54-16.



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#2 It's efficient . . . assures thorough dispersion of quality rubber doughs and cements.

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FIRMS . . .

Ohio-Apex Div., Food Machinery and Chemical Corp., has started construction on a new building for the manufacture of a diallyl phthalate prepolymer, Dapon. The plant will be built at the site of present operations in Nitro, W. Va.

Brooks Equipment and Manufacturing Co. has been acquired by the Ingersoll Kalamazoo (Mich.) Division of Borg-Warner Corp. and will be operated as a subsidiary of the parent company.

American Brass Co. will soon start construction on a new \$13 million brass mill in Los Angeles County, Calif.

Danaho Refining Co.'s new platformer to make premium grade motor gasoline is on stream at the company's Pettus plant.

A. Maschmeijer, Jr., Inc., Newark, N. J., has been acquired by Shulton, Inc., and will be operated as a division of Shulton.

Simplicity Engineering Co., Durand, Mich., has a new Canadian subsidiary, Simplicity Materials Handling, Ltd. The new firm will be located at Guelph, Ont.

Tennessee Products & Chemical Corp. has started production of ferro chrome at its Alton Park plant in Chattanooga.

General Portland Cement Co. will spend more than \$1.5 million in an expansion and rehabilitation program at its Chattanooga plant.

Poly-chemical Industries Ltd., Edmonton, Alta., will construct a \$225,000 plant, southeast of Edmonton, to convert polythene into pipe, tubing, sheeting and packaging film.

Annstrong Cork Co. will expand its Macon, Ga., plant to double its present capacity, making it one of the largest fiberboard mills in the world. ANNOUNCING A
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non-magnetic steel for the chemical, oil and packing industries . . . for ANY installation where, high resistance to heat, acids, chemicals, and corrosion is needed.



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In both size and type, there is a Kerrigan Weldforged grating for every need. Let our new catalogs prove it to you. Send for the one you think best answers your need (or ask for ALL FOUR if you wish). We will also be glad to send you a desk-size grating sample. Write Kerrigan Iron Works, Inc., General Sales Office, 274 Madison Ave., New York City.



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spark-proof for those whose need is strength AND lightness. Extra safe and strong. Allowable fiber stress 15,000 psi. Modulus of elasticity 10,000,000 psi.



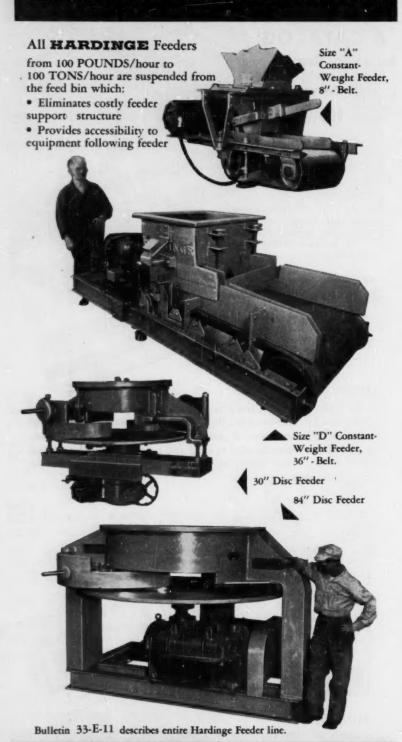
where it is desired to match existing grating.



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#### FIRMS . . .

Southwestern Engineering Co., Los Angeles, Calif. has been awarded a Brazilian contract, calling for design and erection supervision for an asphalt plant and crude terminal facilities for Petroleo Brasileiro, S. A.

Applied Research Laboratories, Glendale, Calif., has announced the completion of facilities for the design and manufacture of x-ray and gamma ray optical elements and instruments.

Stauffer Chemical Co., New York, recently completed an expansion of its Bayonne, N. J. plant for manufacturing, processing and formulating insecticides.

Horizons Titanium Corp. and Horizons Zirconium Corp. have merged. Both companies have been doing research work in rare metals.

Albert Trostel & Sons Co., Inc., Milwaukee, Wis., tanner for side upper leathers, signed two license agreements with Mobay Chemical Co. for the manufacture of both polyurethane rubber materials and polyurethane rigid and flexible foams.

Texas Co.'s second and third new combination UOP Platforming-Unifining units have gone on stream at the company's El Paso and Amarillo, Tex., refineries. The first is operating at Port Arthur, Tex.

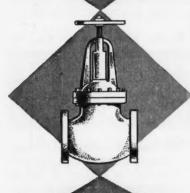
Combustion Engineering, Inc. has received approval from the Atomic Energy Commission for a study of reactor technology.

Koppers Co., Inc. has formed a company-wide marketing department which will embrace primary function formerly carried on by the central staff sales and public relations departments. The new department will also include sales management, market and economic research, sales promotion, advertising and public relations sections.





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Alsop Filters, Mixers and Tanks are available in a complete range of sizes and capacities and Alsop equipment is custom fitted to your particular application by engineers who have thorough experience in filtration and agitation. Look for the proved features in the benefits that Alsop Filters, Mixers and Tanks can bring to your processing operations. Write for full information, recommendations and quotations.



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# How to get along without a Dust Collector

Except when used to recover a product, dust collectors are undesirable. They use valuable plant space, consume needed power, cost money, and worst of all, they are non-productive. To escape the need for one, simply:

- Provide all your employees with respirators.
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However, if you would prefer a dust collector, our Model D AEROTURN\*, which combines high-efficiency filtering with reverse-air-jet filter cleaning, may be just what you need. This compact unit saves valuable space; eliminates erection costs because it comes to you assembled and ready to operate. Standard

unit capacities from 500 to 7200 CFM. For more information ask for the Model D Bulletin.



\*Manufactured under Hersey Patent Rights. Other patents pending.

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"Buffalo Double Suction Pumps are the finest example of the "Q" Factor\* that gives you the most for your pumping doilar. Hydraulically balanced, highly efficient and durable. In sizes to deliver from 10 to 14,000 gpm for circulating, air conditioning, other plant services. Request Bulletin 955-Q.

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For boiler feed and other clear water service against high pressures, write for Bulletin 980 and see how efficiently these rugged "Buffalo" Type "RR" Pumps perform. In 2 and 4 stages to handle up to 500 psi. Capacities up to 900 gpm.

### PAPER STOCKS

For handling high consistency liquids, you'll save money and trouble with non-clogging "Buffalo" Paper Stock Pumps. Available in alloys or rubberlined for corrosive and abrasive liquids. A pump for every job described in Bulletin 953,

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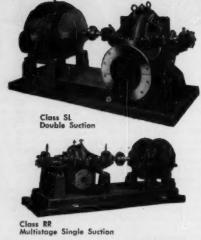
A complete line of "Buffalo" Pumps, ready to handle corrosive or abrasive liquids at least maintenance cost. Write for Bulletins 976 and 982.

### OTHER PUMPS

"Buffalo" builds Vertical Ejectors, Sewage Pumps, Fire Pumps, Marine Pumps and the husky, space-saving Close-Coupled Pump shown. In short, there's a "Buffalo" Pump for best results in any application you may have in mind. Write us about your problem!



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Class CCL Close-Coupled Write for Bulletin 975-D

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A BETTER CENTRIFUGAL PUMP FOR EVERY LIQUID

#### FIRMS . . .

Carter Oil Co. has the world's first commercial fluid coking unit—using a new process which makes possible the manufacture of more gasoline and home heating oils from crude oil—at its Billings, Mont., refinery. The coking process was developed by the Esso Research and Engineering Co.

North American Aviation, Inc. will build the first nuclear reactor designed for private industrial research for the Armour Research Foundation.

Detroit Edison Co. has disclosed plans to contribute \$5 million to build a \$45 million atomic power plant in the Detroit area. The plant will be built and operated by a non-profit corporation yet to be formed. Detroit Edison will buy steam from the unit to generate electricity.

Hooker Electrochemical Co., Niagara Falls, N. Y., has merged with Durez Plastics & Chemicals, Inc., North Tonawanda, N. Y. Durez will henceforth be known as the Durez Plastic Division of Hooker.

Monsanto Chemicals Ltd., London, is beginning large-scale production in England of sodium phosphates and other phosphorus compounds. A new whollyowned subsidiary company, Monsanto Phosphates, will be formed to erect and operate plants in the United Kingdom. First major installation will be at Newport, Monmouthshire, Wales, for production of sodium polyphosphate.

Standard Oil Co. (Ind.) will soon begin construction of its largest crude oil distillation unit at Whiting, Ind. The new equipment, when completed, will increase refining capacity at Whiting to about 220,000 bbl. a day in 1956.

Sinclair Oil & Gas Co., affiliate of Sinclair Oil Corp., acquired the



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Packless • Piston-Pilot Operated • Globe Bodies • Union Bonnet • Certified Alloy Castings • Screwed or Socket Weld Ends • Full Ports to 1000 psi.

Guaranteed Greenclad molded coils for temperatures to 250 deg. F. Whiteclad coils also guaranteed for higher temperature service.

Explosion Proof Coil Housings and special assemblies available to meet the most exacting applications. \( \frac{1}{6}'' \) and \( \frac{1}{4}'' \) Type G stainless steel direct lift valves are also manufactured.

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NEW INEXPENSIVE ACCESS PLATFORM

Swings horizontally-always level, stable. Lightweight. Raises and lowers by hand operated hydraulic mechanism—usable on all sizes of tank cars. Stairway or ladder arrangement optional. Piping not furnished.



Platform provides safe handling of fuel oils and miscellaneous chemical liquids. Write today for information.

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Charging the Abbé Dispersall Mixer described here

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Here's what a user in the ceramic field has to say about fast mixing cycles:

"We mix a 5000-lb. charge of air-floated clay and other ingredients in a total of 60 minutes—35 minutes to charge, and 25 minutes to mix. Our experience has been that a similar amount of slip with the standard equipment used in the industry would require several blunges for the same amount of ingredients. Before installing the Abbé Dispersall Mixer, our blunging cycle was a minimum of 4 hours per mix."

### FOR MOST FLUID MIXES AND PASTES

... the Abbé Dispersall Mixer gives you power and speed, plus the tremendous advantage of easy cleaning, which readily allows shifting from one color or formulation to another. Tooth pastes, creams, ointments, latex and other paints, inks, colors, pharmaceuticals... these are just a few of the products that are mixed and dispersed better and faster in the Abbé Dispersall Mixer in a ONE-stage operation

WRITE FOR CATALOG 68

ABBE ENGINEERING COMPANY 50 Church Street · New York 7, N. Y.

#### FIRMS . . .

properties and assets formerly owned by American Republics Co. The transaction adds some 2,600 bbl. a day to Sinclair's own total production of liquid hydrocarbons.

Magnolia Petroleum Co.'s giant thermofor catalytic reforming unit was put on stream in mid-March. The process is designed to reform naphthas and low-octane gasolines through a catalyst-aided molecular change into very high octane fuels. Capacity is 19,000 bbl. daily.

Ideal Cement Co. has started exploration for uranium in a 150-to 200-mile radius of Laramie, Wyo.

Procter & Gamble plans to build a multi-million dollar drug products plant in Iowa City for production of the company's expanding line of shampoos, home permanents and dentifrices.

Brea Chemicals, Inc. has completed a 210,000 gal. aqua ammonium phosphate plant at Fresno, Calif.

Hongkong and China Gas Co. plans to erect a new \$700,000 plant for manufacturing coal and oil gas.

Catalytic Construction of Canada, Ltd. has formed a new engineering division at its headquarters in Sarnia, Ont.

Linde Air Products Co., Division of Union Carbide and Carbon Corp., is installing equipment for the production of liquid oxygene at its Seattle, Wash., plant.

J. R. Simplot Co. has announced a \$1 million phosphatic and anhydrous fertilizer storage program at Pocatello, Idaho. Four 350-ton phosphoric acid tanks, vacuum coolers for phosphoric and a 1,500-ton spherical tank for storage of anhydrous ammonia will be erected.

PHOSPHORUS (Yellow or White)

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PHOSPHORUS TRICHLORIDE

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DRYORTH®-anhydrous-powerful, speedy, heavy-duty sodium orthosilicatean economical constituent of high pH cleaning compounds.

CRYSTAMET®-pentahydrate-for compounding when lower concentration of finished product is desired. Can be used on medium pH jobs.

Cowles detergent silicates are uniform in composition and particle size-dust free -readily soluble-compatible with other alkalies, soaps, phosphates, synthetic detergents and other chemicals.

### FOR USE IN COMPOUNDING

Floor Cleaners **Laundry Products Metal Cleaners Dairy Cleaners Dishwashing Compounds General Purpose Cleaners** Soap Builders **Paint Cleaners** 

Paper de-inking Compounds **Household Cleaners** 

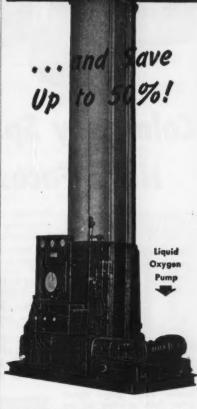
WRITE TODAY for our DRYMET File Folder containing complete technical information and suggested formulations.



## COWLES CHEMICAL COMPANY

7016 Euclid Avenue . Cleveland 3, Ohio

**NOW-Make** Your Own Oxygen and Nitrogen in One Generator



With INDEPENDENT'S newly-designed generators, you can make your own high-purity oxygen and nitrogen from the free air . . . and in the same

You reduce costs up to 50% by eliminating handling costs . . . vaporizing costs . . . evaporation losses . . . residual losses . . . and transportation

INDEPENDENT Generators are available in any capacity, any purity and any pressure. Put your oxygen-nitrogen problem up to us . . . our engineering department will gladly submit recommendations . . . no obligation,

INDEPENDENT ENG. CO., Inc.





# Colmonoy Spraywelding Hard-Faces Valve Plugs



Hamer valve plugs shown after finish grinding of the Colmonoy overlay.

The Colmonoy Spraywelder is a metal spraying unit for applying powdered Colmonoy alloys. These alloys impart superior abrasion and corrosion resistance to finished metal parts. After spraying, the overlay is fused to the part with an oxy-acetylene torch. The Hamer set-up above shows a plug being sprayed while rotating in a lathe.

Longer valve plug life is a goal sought by everyone concerned with valves in the process industries. Hamer Valves, Inc. (California), makers of valves for the petroleum and chemical industries, reports new success in this field.

They're hard-facing valve plugs with Colmonoy No. 4 alloy, applied with the Colmonoy Spraywelder. These Spraywelded plugs last 3 to 4 times longer than hard-chrome plated plugs.

The cement-slurry valve plugs (above) are shown after the Colmonoy overlay was sprayed and fused. The close tolerance spraying will require little grinding to bring plugs to size.



Write for the new Model C Spraywelder Catalog teday.

HARD-FACING ALLOYS

19345 JOHN R STREET WALL COLMONOY DETROIT 3, MICHIGAN

BIRMINGHAM · BUFFALO · CHICAGO · HOUSTON · LOS ANGELES LINDEN · MORRISVILLE · PITTSBURGH · MONTREAL · GREAT BRITAIN



'scuse us for being chesty, but...

... we just can't help crowing about reader-response to CE's first Annual Inventory Issue.

A chemical engineer from Brooklyn calls it . . . "invaluable already, and without precedent." A South Carolina plant manager stopped in to tell us . . . "Yo'all done yo'self real proud." A Dallas man swears . . . "the editor musta come from Texas."

Others went into greater detail on content, arrangement of editorial sections, Reader Service—even the quality of the advertising. Comments and opinions were all over the lot. And they're still coming in.

What do you say? It's your magazine and we're wide open for suggestions. We'd like your ideas . . . for the 1955 Annual Inventory Issue of CHEMICAL ENGINEERING.

ANNUAL INVENTORY ISSUE



A McGraw-Hill Publication, 330 W. 42nd St., New York 36, N. Y.

STEP UP EFFICIENCY

# Knock down Costs of Propane-Butane Heat Exchangers



You can boost efficiency—shave costs as well—when you specify Wolverine Trufin Type S/T for new installations or for retubing propane-butane heat exchangers.

On new jobs Trufin can slash total tube requirements and provide greater heat transfer. That's because integral-finned Trufin provides approximately two times more outside surface area (per lineal foot of tube) for condensing than does plain tube. Trufin cuts unit costs even

more because less tubing means smaller shells, headers, baffles and less maintenance.

When retubing, Trufin can skyrocket the BTU output of old exchangers. Trufin is mechanically interchangeable with prime surface tube and standard fabrication and installation methods can be used. The tube wall at the plain end is heavier than the standard wall at the finned section providing added rigidity and maximum protection at the header.





Here is graphic proof of how Trufin increases surface area.

	"A" PLAIN TUBE HEAT EXCHANGER	TRUFIN TYPE S/T HEAT EXCHANGER
SHELL SIZE O.D.	3'4 inch	34 inch
TUBE SPECIFICATION	7/2" O.D. 16BWG Admiralty Plain Condenser Tubing	1/8" O.D. 16BWG Admiralty Trufin Type S/T
TOTAL OUTSIDE AREA OF CONDENSER TUBING	2,885 sq. ft.	6,552 sq. ft.
TOTAL TUBE LENGTH	12,600 feet	12,600 feet

Trufin is available in a wide range of alloys and sizes to meet your specific processing needs. For additional information and case histories of actual Trufin installations write for a copy of Wolverine's Design Manual "Opportunity."



## WOLVERINE TUBE

DIVISION OF CALUMET & HECLA, INC.

Manufacturers of Quality Controlled Tuling and Extruded Huminum Shapes

# Buy TUBEMANSHIP\*\*

IN CONDENSER and BOILER TUBE

# Buy WOLVERINE!

When you buy electric-welded steel tube from Wolverine you buy the product of Tubemanship. You are assured of condenser and boiler tube designed to deliver maximum performance when the pressure is on. You can count on tubes that are known for long life and dependable service.

Wolverine electric-welded steel tube is recognized as—Qualitube\*. It meets all accepted specifications. Flattening, reverse flattening, expanding and flanging of tube sections are some of the torturous tests that help insure constant weld quality. Each condenser tube is also subjected to hydro-

static tests well over a fibre stress of 20,000 psi.

Qualitube is available in prime surface or with integral fins. It can be fabricated to your specifications and can be held to exceptionally close tolerances. It has a clean, flash-free surface.

Prime surface Qualitube comes in a wide range of sizes and in the following analyses: 1010, 1015, 1020, 1025 and 1030.

Next time your new installation or replacement requirements call for electric-welded steel tube insist on Wolverine Qualitube—reap the long life and the dollar-saving economy of tubing made the Tubemanship way. For complete information write for the Wolverine Steel Tube Catalog.

WOLVERINE TUBE, 1443 Central Avenue, Detroit 9, Michigan.

\*REG. U.S. PAT. OFF.

\*\*Tubemanship—

a Wolverine-coined word standing for constant research, rigid quality control, sound engineering and the work of skilled craftsmen.



Wolverine Trufin is available in Canada through the Unifin Tube Company, London, Ontario

# WOLVERINE TUBE

Manufacturers of Quality-Controlled Tubing and Extruded Aluminum Shapes

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EXPORT DEPT., 13 E. 40TH. ST., NEW YORK 16, N.Y.

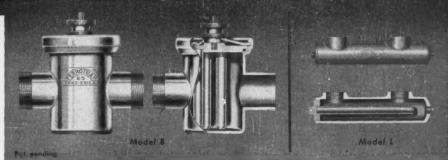
# ON confamination in LIQUIDS and DRY materials eliminated by New ERIEZ MAGNETIC SEPARATORS

New - Eriez Permanent Magnetic FERROTRAPS for Liquids!

## Offer 300%-400% More Magnetic Working Area Than Many Old-Style **Magnetic Traps**

The new line of Eriez Magnetic Ferrotraps (Pipeline Traps) offer, manufacturers protection against damaging fine and tramp iron contamination like they've never had before! Designed for efficient removal of unwanted iron and fines from almost all types of liquids flowing through pipelines, Ferrotraps protect costly screens, pumps, mixers, etc., and prevent ferrous contamination of the product. They are invaluable where product purity is of prime importance, in such applications as foods, drugs, beverages, chemicals, cosmetics,

Quickly installed in any position in new or



existing equipment, Ferrotraps magnetic strength is guaranteed indefinitely. Powerful magnetic unit is easily removed and cleaned; no muss, no small parts to lose. Model B, all stainless steel construction, has been built for standard or sanitary applications and is available for 2", 3" and 4" pipelines. Magnetic ele-

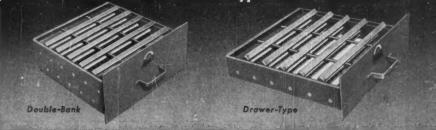
ment consists of multiple fingers, positioned so that the flow of liquid impinges against it. Model B offers utmost protection, while Model L, with one long magnetic element (all-bronze housing), provides good protection at low cost. Model L is adaptable to pipelines from 1/2" to 2". Both models withstand pressure of 150 psi.

For complete information about both models, request Bulletin B-605.

# New - Eriez Permanent Magnetic Double-Bank and Drawer-Type GRATE MAGNETS!

# For Free-Flowing Choke and Surge Fed DRY Materials

Designed for removing tramp iron and fines from free-flowing dry materials such as grains, coffee, dried fruits and foods, tobacco, pelleted products, etc., Eriez Grate Magnets now are available in single or double-bank units in wing and drawer types. In double-bank unit, second row of magnetic tubes is placed directly under open spaces of top row for increased efficiency. Protective iron grill guides flow of material onto powerful magnetic tubes. For use



in floor openings, regular or odd-shaped hop-pers, chutes and ducts. Intensive magnetic barrier does excellent job of removing iron contamination.

For installation in vertical closed chutes and ducts, Eriez Drawer-Type Grate Magnets offer highly efficient protection plus roll-out con-venience. Single or double-bank units. Entire separator glides out on metal slides for quick, easy cleaning. Installation is fast and simple . . . latch (furnished) and gasket make dustight installation.

Eriez Grate Magnets, wing-type and drawertype, come in 162 sizes, from 2½" x 4", to 36½" x 36". Special sizes made to order. Complete line is available in all-stainless steel construction. For additional information, request Bulletin B-214.

NOT NAILED TO THE FLOOR! Here's an idea for publicity men who used to create "gag shots" by nailing down shoes. Just use a piece of iron on the heel of the shoe and an Eriez magnet under the rug. To industrialists, however, this demonstrates another idea — powerful magnetic action which can quickly be put to work pulling dangerous tramp iron out of processing lines... tramp iron which causes fires, machinery damage and product contamination. All Eriez Magnets are non-electric, self-contained. They operate without wires or attachments. Best of all their magnetic power lasts a lifetime. The first cost is the last.

• Eriez' free booklet "Magnetic Ideas" can help you. Send for it without obligation. ERIEZ MANUFACTURING COMPANY, 74T Magnet Drive, Erie, Pa. OR on your specific request Eriez factory-trained field men backet by Eriez' laboratory and engineering know-how, will be happy to study your particular problem, make a plant survey and offer helpful "Magnetic Ideas."

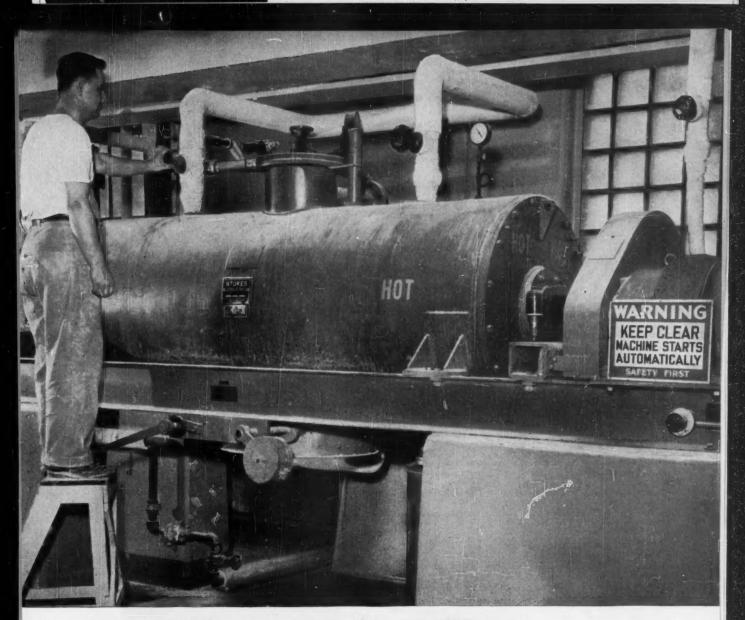


# McLouth STAINLESS

High quality stainless sheet and strip steel . . . for the product you make today and the product you plan for tomorrow.

McLouth STEEL CORPORATION DETROIT, MICHIGAN

Manufacturers of Stainless and Carbon Steels



# Weed-killer production problem solved by STOKES vacuum dryer

A leading chemical manufacturer asked us, "What equipment can we use to dry 6 tons per day of a heat-sensitive weed-killer from a true solution containing 67% dissolved solids to a crystalline product of 99.75% solids? Maximum allowable temperature is 50° C and we must crystallize and dry in one operation."

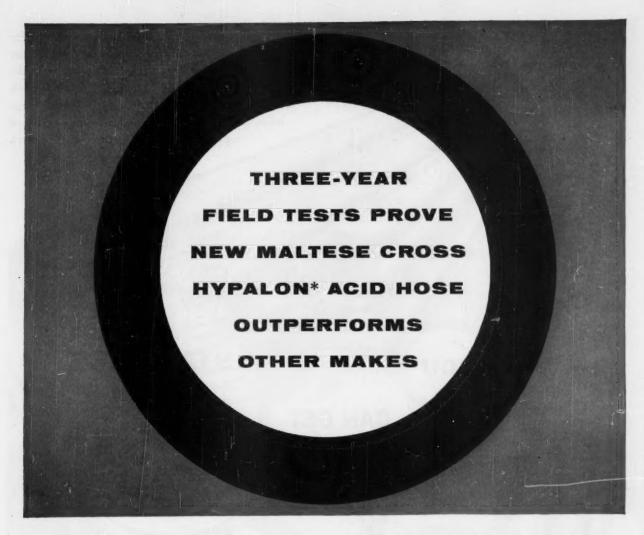
Stokes engineers developed the answer from broad experience with drying problems . . . confirmed it by tests on the chemical in the fully equipped Stokes laboratory . . . recommended a Stokes rotary vacuum dryer sized to give the needed production on a predetermined drying cycle. The unit was purchased and is now on the production line.

This combination of engineering knowledge and laboratory research—the result of 40 years in the design and application of complete vacuum processing systems—is available to all chemical manufacturers. A typical Stokes Rotary Vacuum Dryer is illustrated. Write for informative literature on Stokes Vacuum Drying Equipment, Catalog No. 720, and for the new booklet on Stokes Laboratory facilities, Bulletin No. 640.

F. J. STOKES MACHINE COMPANY, PHILADELPHIA 20, PA.

STOKES





Three years ago chemists at the Hewitt-Robins Research Laboratories in Buffalo produced an experimental acid hose having a tube compounded with Hypalon, a remarkable new polymer developed by Du Pont. Intensive laboratory tests immediately indicated that this new product, Maltese Cross Hypalon Acid Hose, had acid-resistant properties unequalled by any other hose. The question was, would it perform equally as well in actual industrial applications as it had in the lab? To find the answer, many lengths of this new hose were put to work at industrial installations throughout the country, handling different types of acids under various operating conditions.

Now, after three years, the reports are in . . . the results show Hewitt-Robins' new Maltese Cross Hypalon Acid Hose has conclusively proven superior in case after case!

Here is a typical field report: "In September, 1952, a 50' length of 2" hose was installed for testing at the Hilfinger Corporation, Toledo, O. Since that time it has been used every other 8-hour shift to handle chromic acid (40% solution by weight) at 105° F. Whereas all previous hoses had failed in 6 to 8 months due to the effect of the acid on the tube, Maltese Cross Hypalon Acid Hose is still in service and as yet shows no sign of deterioration."

Get all the facts about how Hewitt-Robins' new Maltese Cross *Hypalon* Acid Hose can improve your acid handling hose service. For immediate information, contact your local Hewitt-Robins Industrial Supply Distributor (see classified phone book) or write directly to our executive offices in Stamford, Connecticut.

\* Reg. T. M. Du Pont Company HYPALON chemical rubber.

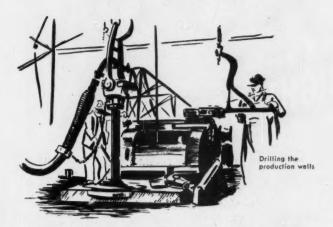
Conveyor Belting & Machinery— Vibrating Equipment— Industrial Hose



Conveyor Design & Engineering— Molded Rubber Products

HEWITT-ROBINS INCORPORATED . EXECUTIVE OFFICES: STAMFORD, CONNECTICUT

FAST SERVICE IS CHASE'S SPECIALTY! Not only for brass, copper and bronze, but now for stainless steel, too! Chase Warehouses and Sales Offices stand ready to rush you the type, size and quantity of stainless steel tubing or pipe you need. You get the same kind of dependable service that has made Chase the nation's headquarters for brass and copper. Call Chase today for stainless steel. **STAINLESS** YOU STEEL CAN GET pipe and tubing from BRASS & COPPER CO. TERBURY 20, CONNECTICUT . SUBSIDIARY OF KENNECOTT COPPER CORPORATION The Nation's Headquarters for Brass & Copper



# Crude Sulphur for Industrial Use

from the properties of

# Texas Gulf Sulphur Co.

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**Producing Units** 

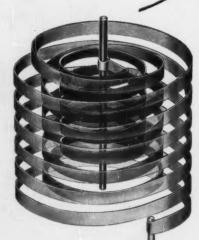
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# DEPENDABILITY



Weston thermometers
with Multiple bimetal helix

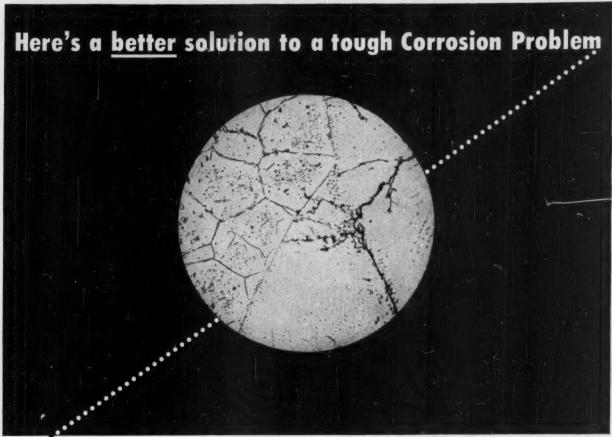
The reasons why WESTON all-metal industrial thermometers excel in dependability and long life...enjoy such outstanding preference throughout industry...stem in large part from Weston's exclusive design and manufacturing methods. The critical sensing elements are all Weston-made in the shorter multiple helix form to insure rugged, nonsagging units. They are then cycle-seasoned, over broad temperature ranges, to insure consistently precise indications over far longer periods. Thus they serve better, longer, at far lower over-all costs. Bulletin containing sizes, ranges and prices, available on request. WESTON Electrical Instrument Corporation, 614 Frelinghuysen Ave., Newark 5, N.J.



WESTON

Thermometers

AVAILABLE THROUGH LEADING DISTRIBUTORS



# 

The corrosion-inviting cracks in the right-hand section of the photomicrograph above end abruptly as they near the center of the picture... and that quick ending may help you find a quick ending to stress corrosion cracking problems.

The picture is Carpenter 7Mo stainless pipe (left) welded to a Type 316 fitting. It is still unaffected by the stress corrosion cracking that has destroyed the usefulness of the fitting. The pipe outlasted three such fittings before the photomicrograph was made.

The stout resistance of Carpenter 7Mo to stress corrosion cracking, even in the presence of chlorides

or other caustic and sulphite solutions, is coupled with excellent resistance to general corrosion and pitting. It has been used as a "problem solver" in food and chemical processing plants, pulp mills, petroleum refineries and other places. There may be a profitable place for it in your operation. We'll be glad to work with you, aid you in investigation of your problems and a possible 7Mo solution.





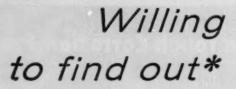
The Carpenter Steel Company, Alloy Tube Division, Union, N. J.

Export Dept.: The Carpenter Steel Co., Port Washington, N. Y .- "CARSTEELCO"



Write for your copy of the Carpenter 7Mo Technical Bulletin containing comprehensive data.





The Research Division is another facet of Fluor's multi-service operations under a single responsibility. The Research Division designs new or improved processes and products which are offered by Fluor to industry.

It conducts laboratory and pilot plant experimental studies to provide technical data to other Fluor divisions and to their customers. It furnishes

Fluor divisions and to their customers. It furnishes consulting services in fields of specialized knowledge, and maintains a broad contact with the technical and economic trends of the industries it serves.

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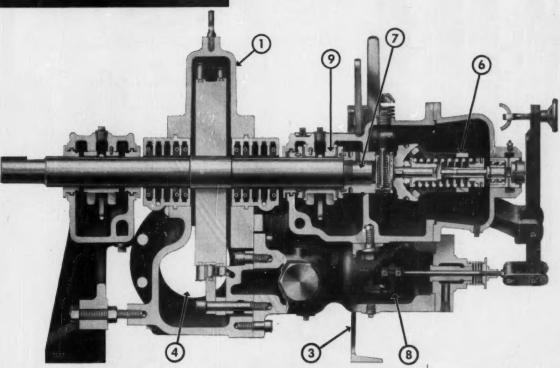
There are many practical advantages of dealing with an engineering and construction firm that appreciates the value of research, who has the manpower and facilities to conduct a thorough research program concurrently with engineering and construction (no need to delay a construction project while research is being concluded), and who possesses an unbounded willingness for finding out. For more information on Fluor's Research facilities write for Bulletin FC 8.001R.

\* "Research means you do not know but are willing to find out" - CHARLES KETTERING

# NEW DE LAVAL **HCB**

SINGLE STAGE TURBINE

# can be ordered from stock



- 1 Case and Cover Split Horizontally on centerline for ease of maintenance.
- 2 True Centerline Casing Support assures distortion-free radial expansion. Not shown.
- 3 Flexible Support at governor end provides for axial expansion.
- 4 Exhaust Opening either right or left side for installation flexibility.
- 5 Steam Strainer, protecting trip and governor valves, is removable for cleaning without

breaking steam connections. Not shown.

- **6 Constant Speed Governor** features governor weights pivoted around frictionless surfaces.
- 7 Complete Governor Assembly is now replaceable as a unit.
- 8 Balanced Single Seated Main Governor Valve has proportional flow characteristics for sensitive, positive control.
- 9 Shaft Locating Bearing of adjustable double collar type.

Horsepower: 100 MAX Steam Pressure: 300 PSIG MAX Steam Temperature: 550F MAX Exhaust Pressure: 25 PSIG MAX Speed: 4,000 RPM MAX Steam Inlet: 2"-250# ASA FLG. Exhaust: 6"-150# ASA FLG. Weight: 1,200 LB

Here's the new De Laval HCB Single Stage Turbine which is now "on the shelf" . . . ready for immediate shipment. This mechanical drive turbine is simple, rugged, designed for long economical life and low maintenance. For example, note the true centerline casing support, the replaceable governor, the removable steam strainer. Investigate all the advantages of this versatile driver. It is ready to handle-at low cost-a variety of applications in your plant.

> Send for new Bulletin 4206 which gives vital facts and figures



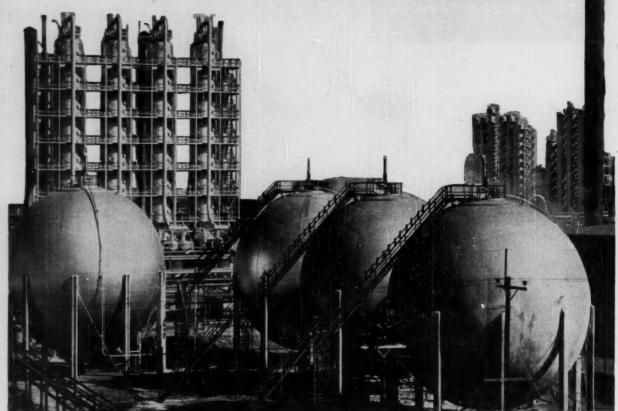
LAVAL Mechanical Drive Turbines

DE LAVAL STEAM TURBINE COMPANY

803 Nottingham Way, Trenton 2, New Jersey

DL 205

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Since Chlorine is produced under highly corrosive conditions and because United States Rubber Company's specially compounded Permobond #5471 proves superior for lining the amalgam type cells plus the piping and process tanks, then you can be sure that U. S. Permobond is the right lining for all chemical processes using this highly corrosive basic chemical.

Any original equipment requiring protection against corrosive attack can be lined with Permobond. You can also have Permobond installed on existing equipment—right in your own plant.

**U.S. PERMOBOND PROTECTS AGAINST** 

- WET OR DRY CHLORINE
- TEMPERATURES UP TO 200°F.
- SATURATED CHLORINE SALT BRINE REGARDLESS OF CONCENTRATION

"U. S." has a field force of special sales engineers to solve your corrosion problems. Get in touch with them at the address below.

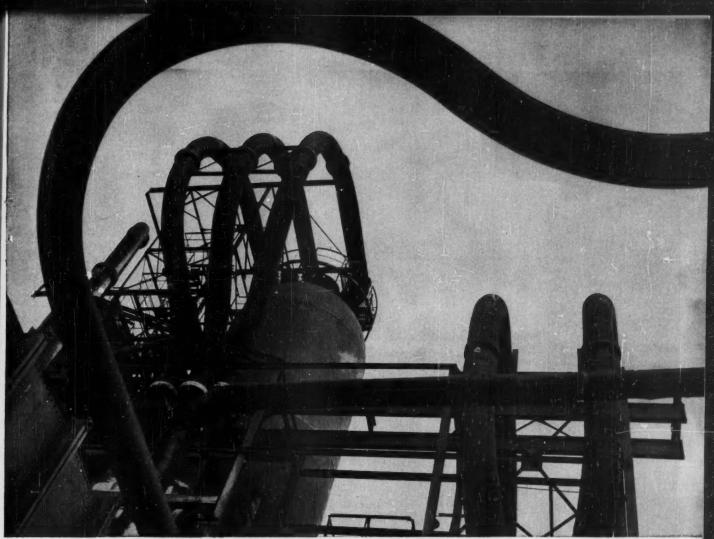
FROM EVERY STANDPOINT, PERMOBOND #5471 IS THE SUPERIOR LINING.



"U. S." Research perfects it..."U. S." Production builds it... U. S. Industry depends on it.

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MECHANICAL GOODS DIVISION . ROCKEFELLER CENTER, NEW YORK 20, N. Y.

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Molded and Extruded Rubber and Plastic Products · Protective Linings and Coatings · Conductive Rubber · Adhesives · Roll Coverings · Mats and Matting



Carey insulation materials have weathered 25 years of continuous service on the fractionating tower and vapor lines of these atmospheric and vacuum stills at Gulf Oil Corporation's Port Arthur, Texas plant,

### 25th Anniversary of tough Texas service at Gulf

### ... Carey Magnesia Insulations defy vibration, humidity, heat!

Continuous outdoor service for 25 years! That's the record set by Carey magnesia insulation at Gulf Oil Corporation's big refinery, Port Arthur, Texas. And here, service conditions are really rugged. Besides the unmerciful vibration, expansion and contraction present in every refinery operation, you have blazing sun, high winds, heavy rains and corrosive salt air! Carey's experience in development and manufacture of insulation products since 1873 is one big reason why Carey insulations are so outstanding. And it's the reason, too, why we believe we can help you solve your heat insulation problems, unusual though they may be.

The Carey line includes insulation for sub-zero to 2500° F service. Major products are Super-Light 85% Magnesia and Tempchek in precision-sized blocks and nesting "O. D." pipe coverings; blankets; pipe wrapping and jackets; cements. All excel in ease of application; are economical to use. Ask your Carey Industrial Sales Engineer for helpful advice.

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### WHAT HAPPENS NEXT?

If management has been wise, a fire tragedy will be stopped before it starts...if not, in 20 minutes extensive destruction and total loss could readily be the result.

First-rate fire protection is essential to the continued success of any business. With C-O-TWO Smoke or Heat Fire Detecting Systems, plus C-O-TWO High Pressure or Low Pressure Carbon Dioxide Type Fire Extinguishing Systems, as well as PYRENE Air Foam Type Fire Extinguishing Systems for specific outdoor locations, your plant can have fast, positive round-the-clock fire watchman service simultaneously at each fire hazard point . . . a fire tragedy is stopped before it starts.

Furthermore, there is a personal sense of responsibility inherent with PYRENE—C-O-TWO Fire Protection Engineers that assures you of fully adequate firesafety . . . a definite plus in your behalf. Whether it's fire detecting or fire extinguishing . . . portables or built-in systems . . . PYRENE—C-O-TWO means top quality backed by experienced engineering that results in operating superiority for you at all times.

Act now...don't take unnecessary chances with your investment any longer... the extensive experience of PYRENE—C-O-TWO over the years is at your disposal without obligation. Remember... a plant-wide fire protection survey skillfully executed today could be the means for greater profits tomorrow.



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### COMPLETE FIRE PROTECTION

portable fire extinguishers . . . built-in fire detecting and fire extinguishing systems

CARBON DIOXIDE . DRY CHEMICAL . VAPORIZING LIQUID . SODA-ACID . WATER . CHEMICAL FOAM . AIR FOAM



Want control for Water Heaters, Heat **Exchangers, Processes?** 

You Will Insure Better Temperature Control IF-



you use the right type regulator and proper size control valve. Whether a simple self-operating regulator shown at left is required or the air operated controls featured here . . . you can get both types and others from Powers. For further information call or write our nearest office.

Powers ACCRITEM Temperature Regulator and FLOWRITE Valve—the right combination for many control problems where pressure and load conditions fluctuate widely, also for control of large size valves.

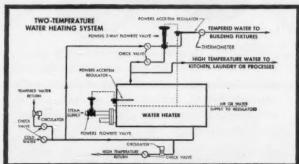
Over 50 Years Experience making this type of regulator

**Control Point** easily changed

Air or water operated

Ranges 50 to 250°F-150 to 350°F

VALVES: Available in a variety of body types and inner valves.

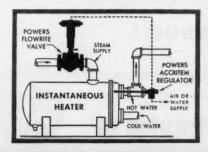


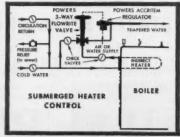
### ACCRITEM TEMPERATURE REGULATOR

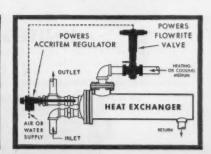
Gives Close Control and Years of Dependable Service.

- · Has Adjustable Throttling Range and Calibrated Dial.
- · Simple, Durable Construction assures years of troublefree service.
- · Easy to Install · Direct or Reverse Acting, reversible on the job.
- Small Size: Regulator head is 2%" wide, 3%" high, bulb is 12" long with ½" IPS Connection.

Fully Described in Bulletin 316. Write for a copy.





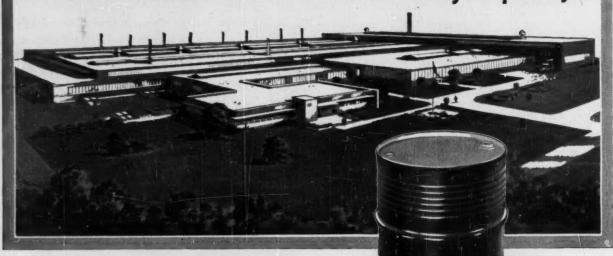


REGULATOR COMPANY

Skokie, Ill. • Offices in Chief Cities in U.S. A Also Canada and Mexico • See your phone book

# NOW THERE ARE 7 U. S. STEEL PRODUCTS PLANTS

...located from coast to coast to serve you quickly!



THIS BIG, NEW, ULTRA-MODERN PLANT near Camden, New Jersey will help meet the growing demand for USS Steel Drums.

The ever-increasing nationwide demand for USS Steel Drums has given birth to our new plant near Camden, New Jersey. It has the most modern drum- and pail-producing facilities of any container plant in the country. Its high-speed production lines will be capable of turning out millions of drums and pails a year. And after production gets into full swing, we will be able to quickly fill your order and deliver to meet your production requirements.

This fast service, coupled with the famous USS high quality, gives you the combination you need.

And now, through our coast-to-coast plant network, we can offer you a *complete* line of drums and pails . . . including stainless, galvanized, tinned, painted and decorated in a wide range of capacities with a variety of fittings and openings.

"It's Better to Ship in Steel"

### **UNITED STATES STEEL PRODUCTS**

DIVISION

UNITED STATES STEEL CORPORATION

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### USS STEEL DRUMS



UNITED STATES STEEL

### Be Wise-Economize-Standardize-Simplify Stock Problems-with the AO† R5000 RESPIRATOR\*

Here's complete respiratory protection in one "package"! If you have several respiratory hazards to control, the & R5000 will save you inventory problems and money. This ingenious twin cartridge respirator converts to many types of protection quickly merely by interchanging the filters and cartridges. Ask your nearest & Safety Products Representative.



R561 — For heavy duty protection against highly toxic insecticides such as Systox, Parathion, Aldrin, Dieldrin, Chlordane, EPN, Nicotine, TEPP and HETP. Respirator protects against all dusts, mists, metal fumes and organic vapors. Approved by U. S. Dept. of Agriculture.



R563 — For heavy duty protection against metal burning fumes, acid gases, organic vapors—all dusts, mists.



R50 — For combination of all dusts, not significantly more toxic than lead. B.M.2156



R50A — used with R50, converts to a dust and mist respirator. Protects against all dusts not significantly more toxic than lead, pneumoconiosis-producing mists, chromic acid mists. B.M. 2156 includes B.M.2156A



R51 — For light organic vapors and gases of paint spraying, degreasing, dry cleaning, B.M.2304



**R52** — For acid gases, and mists of plating operations, pickling tanks, etc.



R53 — For combined acid and organic gases like carbon tetrachloride and acetic acid.



R54 — For protection against low or nuisance concentrations of ammonia.



R55 — For those who are exposed to both organic vapors and all dusts not significantly more toxic than lead. B.M.2305

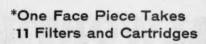


R56 — For fumes produced in welding, burning, smelting and refining. B.M.2163





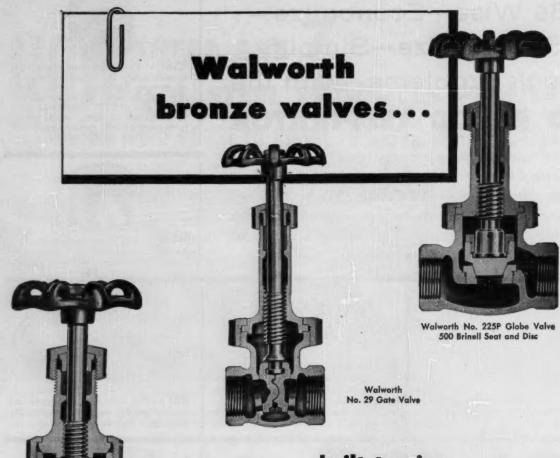
**R57** — For dusts, mists, fumes, significantly *more* toxic than lead including radioactive particulate matter.



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# dependable trouble-free service on all recommended jobs

Walworth No. 95 Bronze Globe Valves (Angle Type: No. 96) are recommended for service where throttling is not required. They are rated at 150 psi working steam pressure, 500F; 300 psi cold water, oil or gas. The improved renewable disc and lock-on, slip-off disc holder — an original Walworth development—saves time and trouble. This valve can be repacked under pressure when fully opened. All parts are designed to give maximum service and strength.

Walworth No. 29 Bronze Gate Valves are rated at 200 psi working steam pressure, 550F; 400 psi cold water, oil and gas. These valves have rising stems and integral seats. Sizes 2-inch and smaller have union bonnets; sizes 2½ and 3-inch have bolted bon-

nets. Valves up to and including ¾-inch have solid wedge discs; 1-inch and larger have split wedge discs. These valves can be repacked under pressure when fully opened.

Walworth No. 225P Bronze Globe Valves (Angle Type: No. 227P) are rated at 350 psi working steam pressure, 550F; and 1000 psi non-shock service on cold water, oil and gas. The stainless steel, plug type seat and disc — heat treated to 500 Brinell — can be closed on sand, slag, scale and similar floatage, without injury to the seating surfaces. They are the longest wearing, TOUGHEST bronze valves you can buy.

For full information about Walworth Quality Bronze Valves, see your Walworth distributor, or write:



Walworth No. 95 Globe Valve Re-New-Disc





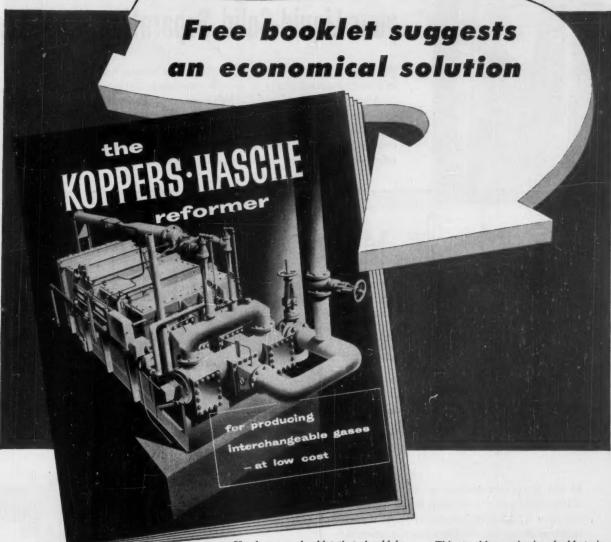
WALWORTH valves and fittings

60 EAST 42nd STREET

NEW YORK 17, N. Y.



# Gas-Supply Problems?





### KOPPERS COMPANY, INC.

Engineering and Construction Division
Chemical Department
Pittsburgh 19, Pennsylvania

Here's a new booklet that should be "required reading" for industrial plants that use gas on an interruptible contract. It describes the Koppers-Hasche Reformer—the reformer that produces low-cost gas that is interchangeable with most natural or manufactured

This booklet tells how a Koppers-Hasche Reformer can "carry on," when there is any interruption in the supply of gas, until normal service is resumed. This stand-by service is valuable to industries that utilize natural gas or manufactured gas, because it prevents costly interruptions in the manufacturing processes.

After reading this booklet, we think you'll agree that the Koppers-Hasche Reformer is ideal insurance for gas-supply emergencies and peak loads. Get your copy of this informative booklet by filling out and sending in the handy coupon.

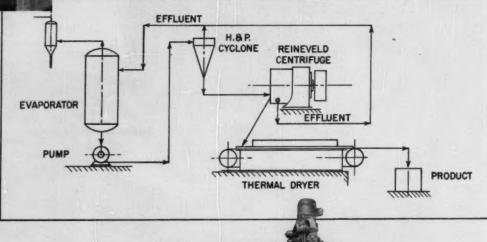
Koppers Company, Inc., Engineering and Construction Division Chemical Department, Pittsburgh 19, Pennsylvania
Please send me, without charge or obligation, a copy of your new booklet on the Koppers-Hasche Reformer.
Name
Address
CityState



# HEYL & PATTERSON can help you with your Liquid-Solid Separation problems

In a large chemical plant Heyl & Patterson Cyclones are currently used to classify a caustic slurry of sodium chloride at 200 mesh.

Slurry from a horizontal tube steam evaporator is fed to 8" H & P Cyclones. The Cyclone overflow, containing minus 200 mesh material is returned to the evaporator for further crystal growth. The underflow, containing plus 200 mesh material, passes to the next processing stage, using the Reineveld Centrifuge to dry the crystals.

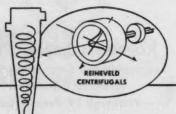


In the Reineveld processing method the sodium chloride slurry is fed into the machine rapidly, creating turbulence in the rotating drum. As the speed of the liquid approaches the speed of the drum, the turbulence is lessened.

During this period Centrifugal Force deposits the largest crystals against the screen cloth; then successive layers of crystals of smaller particle size, until the very finest crystals are deposited last on the crystal bed. The formation of this superior filter bed results in lower effluent losses and rapid liquid drainage.



55 FORT PITT BLVD. . PITTSBURGH 22, PA.





# Then Save Time and Money with THE LIXATE PROCESS

In a single piece of equipment, The Lixate Process combines a method of dissolving rock salt without agitation and a method of filtration.

### MAKES BRINE AUTOMATICALLY

The Lixator makes and filters all the brine you want or need with no human aid whatever and can be located *anywhere*—even hundreds of yards from buildings and points of use.

### UNIFORM QUALITY AND STRENGTH

The Lixator produces only 100% fully-saturated brine, self-filtered, crystal clear. May be accurately reduced in strength, without testing, without delays.

### PIPED TO POINTS OF USE

Turn a tap, there's your brine—where you want it, when you want it. No handling of salt or finished brine. Economy! Convenience! Efficiency! All Lixator installations are custom-engineered.

### EVAPORATED SALT DISSOLVERS, TOO

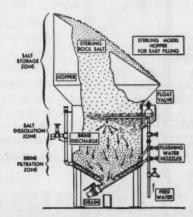
Rock Salt or Evaporated Salt—International provides both in all forms. It provides also any technical advice on salt, brine, or auxiliary equipment, required by users, for either kind of salt.

### INTERNATIONAL SALT COMPANY, Inc.

Scranton, Pa.

SALES OFFICES: Atlanta, Ga. • Chicago, Iil. • New Orleans, La. • Baltimore, Md. • Boston, Mass. • Detroit, Mich. • St. Louis, Mo. • Newark, N. J. • Buffalo, N. Y. New York, N. Y. • Cincinnati, O. • Cleveland, O. • Philadelphia, Pa. • Pittsburgh, Pa. • Richmond, Va.

ENGINEERING OFFICES: Atlanta . Buffalo . Chicago



### HOW LIXATOR WORKS

Rock Salt, fed by gravity, keeps tank filled. Water in dissolution zone dissolves salt, becomes 100% saturated brine. Lower bed of rock salt acts as filter. Result-crystal clear, fully saturated brine.

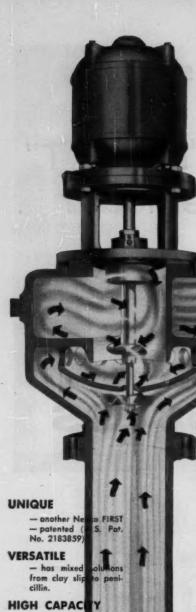
It costs nothing to find out what The Lixate Process.

International Salt Co., Inc. Industrial Division, Scranton 2, Pa.

Without obligation, please have an International Industrial Engineer call to show me how The Lixate Process might be adapted to my plant.

Name\_\_\_\_\_\_\_Title\_\_\_\_\_\_
Firm Name\_\_\_\_\_\_
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City Zone State



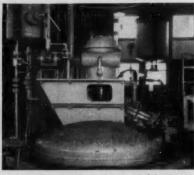
FOR CONTINUOUS MIXING . . .

FLOMIX

Use Nettco Flomix to combine liquids, gases and liquids, and liquids and solids as they flow through a pipe line. Flomix gives you these important advantages: • fast, uninterrupted processing, • increased uniformity of product, • simplified piping layouts, • complete elimination of intermediate storage tanks and mixing vessels, and • reduced maintenance.

Nettco Agitation Engineers are ready to discuss the application of Nettco Flomix to your continuous processing problems: for mixing, blending, reacting, washing, contacting, bleaching, absorbing, chlorinating, clarifying. Send specifications for engineered recommendations to New England Tank & Tower Co., 87 Tileston Street, Everett 49, Massachusetts.

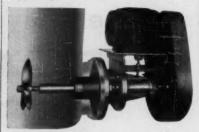
ETTCO NEERED AGITATION





Nettco Model WT Agitator in modern processing plant — an engineered combination of Nettco's standardized units assembled to handle the special mixing requirements of this leading dyestuffs manufacturer. The complete line of Nettco tank top, side entering, and pipe

line mixers, and Nettco agitator accessories is described in our Catalog No. 530. Write for your copy today.





Nettco Model KBA Side Drive Agitator with V-belt drive. Standard Nettco side drive units are available in the full range of horsepowers from 1/3 to 30 . . and in special alloys to meet specific process conditions. Tailored to your requirements with mechanical seal, with

or without shut-off . . . or stuffing box with or without shut-off. For detailed information, ask for Bulletin No. 532.





Nettco Flomix serving in the production of glycerine at a petrochemical processing plant. Write today for your copy of Bulletin No. 531 describing Flomix.

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- to 400 psi.

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- to 300° C.

**PRESSURES** 

TEMPERATURI



# **NEW TOOLS FOR INDUSTRY'S GROWTH!**



Stainless Steel Acid Transports — For nitric acid, acetate solvents, acetic acid and anhydride, aluminum sulphate, ammonium chloride, hydroxide, nitrate, phosphate and sulphate, butadine, calcium bisulphate, formaldehyde.



Carbon Steel Acid Transports — Designed to haul oleum, acids and acid sludge. When lined with the proper substance, used to carry hydrochloric (muriatic), sulphuric, and other acids.



Insulated Low-Pressure Tank-Trailers — Designed to transport hot sulphur, latex, penicillin, paraffin, hot oil, wax, tallow, resins, tar.



Twin Cylinder Tank-Trailers — Designed to haul propane, butane, anhydrous ammonia.



Insulated Hot Commodity Transports — Engineered to haul asphalt, hot oil, crude oil, road oil, tar, pitch, tallow, wax, paraffin, resin, glue.

### Newly-Developed Chemical Trailers By Fruehauf Move Raw Materials and Finished Products Faster!

MANY FIRMS in the chemical industry and allied fields have greatly increased their scope of operations by the use of specialized Fruehauf chemical Trailers.

They have utilized Fruehauf bulk transports for fast movement of raw materials in full or partial loads, wherever and whenever needed, eliminating costly delay, reducing the need for expensive inventories of supplies, and increasing production efficiency.

And they have found that Fruehauf designs the exact Trailer needed to ship finished products — either in bulk, drums, or packages, however needed — directly to customers or distribution points. *Direct* Trailer shipment removes costly in-between delays, re-loading, and re-handling.

If you are growth-minded and cost-conscious, Fruehauf: Trailers — the finest built anywhere — are probably the exact tools you need for greater expansion and economy in your business. It can pay you to investigate!

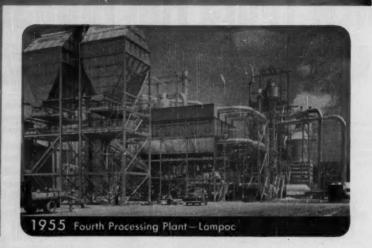


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	Please send me the free booklet, "New Ways To Profit In Many Industries."
	Please send me the complete, new, illustrated folder, "Greatest Line Of Tank-Trailers."
	Please have a Fruehauf representative call to make a "Transportation Cost Analysis" of my business.
	To send this coupon, simply attach to your company letterhead, sign your name and mail—you'll get action!

a quarter
of a century
separates
these DICALITE
pictures







They didn't continue very long—the horse-and-wagon, hand-quarrying methods of our early days. For Dicalite was founded on the idea of development, of promoting new uses for that little-known (in 1930) material, diatomite, and working out improved processing methods.

The succeeding 25 years have, we believe, proved the soundness of that idea. Today diatomite... also called diatomaceous silica, diatomaceous earth or D.E... has important uses in more than 200 industries, and Dicalite has helped in the pioneering and development of many of these uses. Dicalite products, which now number more than 50, have a valued place in the brewing, pharmaceutical, chemical, sugar, food, paint, paper and other large industries, as filteraids, fillers, insulation and in other capacities.

And Dicalite itself has grown—because of this basic idea of development—from 1930's one deposit, one plant, to 1955's four processing plants and deposits in three states. Four locations, four plants, served by four different railroad systems, insure a continuing, dependable supply of the diatomaceous materials upon which many industries rely.



# stability...



### just one of many reasons why KAYLO° is the king of high temperature insulations

Other high temperature insulations may look like Kaylo—but performance brings out the difference. Take stability, for instance.

Even when soaked in water for long periods, or immersed in boiling water, Kaylo (hydrous calcium silicate) not only refuses to break down but, after drying out, shows no apparent shrinking or warping! And its original thermal efficiency and exceptional strength return, too! Moreover, it can be removed and replaced for line inspection without waste.

No wonder Kaylo is called "king of high temperature insulations!"

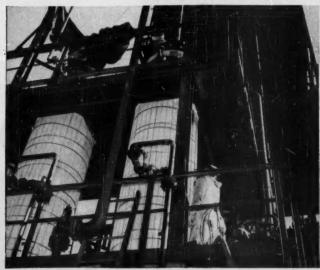
Together with Fiberglas\*—the world's leading industrial insulation—Kaylo rounds out the most complete and versatile line of plant insulations available. It is distributed by Owens-Corning Fiberglas Corporation, and is made both as block and molded pipe insulation with the widest range of sizes, forms and thicknesses of any high temperature insulation.

For complete technical data, see our listings in Sweet's File, Chemical Engineering Catalog, or Refinery Catalog, Or write: Owens-Corning Fiberglas Corp., Dept. 97-F, Toledo 1, Ohio.

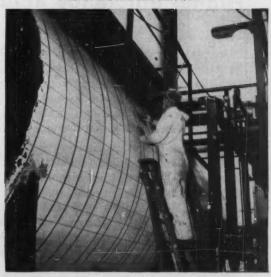
Kaylo and Fiberglas now provide you with complete coverage from lowest sub-zero to 1200°F—
from one reliable supplier.



T. M. Rog. Owens-Corning Fiberglas Corporatio



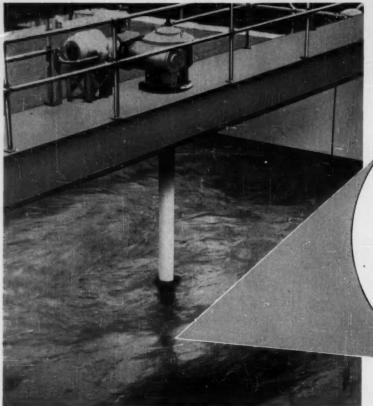
**Kaylo** on a pair of "strippers" in a fractionating plant, one of an increasing variety of industrial applications.



Kaylo block on desalter tank. Strength of material and large units mean more economical application, less waste.

### You get better results





for Mixing
and
Flocculating

Here's why

Radial-flow "VORTI" Mixers and VORTI-FLOC® Coagulators, designed by INFILCO engineers, move larger volumes of liquid at lower impeller speeds than other types.

### Higher efficiency at lower operating cost

"VORTI" Mixers are applicable to most problems of mixing and agitation. The impeller is usually suspended from the top of the basin without the use of underwater guide bearings, stuffing boxes or submerged chain drives.

"Vorti-Floc" units are used for chemical treatment or for self-coagulation. They create gentle flow and turbulence by moving large quantities of liquid at relatively low velocities, thus promoting coalescence and agglomeration of suspended particles.

By proper combination of speed and size of impeller, applications of INFILco radial flow units include:

> Slow stirring for equalization Blending of liquids

Neutralization

Slow stirring for flocculation and agglomeration

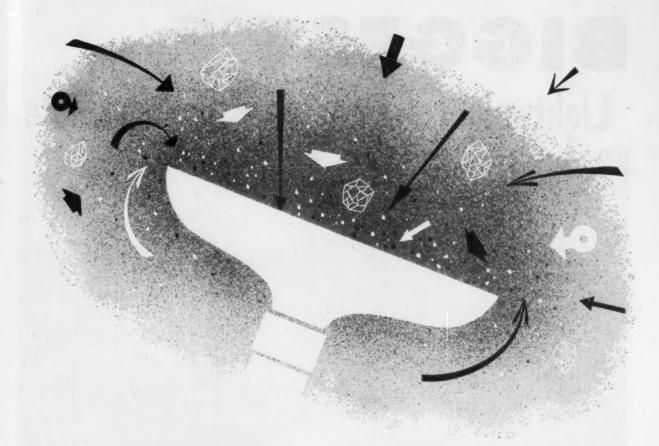
Rapid mixing of chemicals in liquids

INFILCO mixers are efficient and economical. Write today for complete details.



The one company offering equipment for all types of water and waste treatment—coagulation, precipitation, sedimentation, filtration, flotation, acation, ion exchange and biological processes.

INFILCO INC. 905 South Campbell Avenue, Tucson, Arizona Offices in principal cities in North America



### remove ... and control those chemical dusts

### with HOFFMAN INDUSTRIAL VACUUM CLEANING

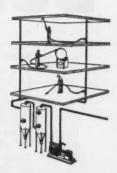
For effective sanitation—and salvage if need be—of dry chemical materials on the loose, you'll find the ideal answer in Hoffman Heavy Duty Vacuum Cleaning.

The powerful suction of the Hoffman system is the perfect supplement to regular ventilating-collecting installations for 100% effective control of dust and dry material.

And the flexibility of the vacuum cleaning is invaluable when there is need for picking up granular, powdered, or dusty materials from locations out of the ordinary. The ease with which a hose and nozzle can be run from a nearby outlet in permanent systems—or a portable vacuum cleaner—for quick, thorough removal, can be especially important when the material has a high cost, nuisance, or danger factor. Recovery of salvageable material is always simple, since all of it is collected in a central receptacle for later disposal.

These additional functions of Hoffman Industrial Vacuum Systems—above and beyond the basic job of keeping premises dry-scoured of dust and dirt, from floor to ceiling, are attracting the interest of alert engineers concerned with maintenance, safety, and materials handling.

Let Hoffman engineers show you the versatility and effectiveness of the Hoffman Industrial Vacuum System in handling dry materials. The coupon will bring you full information in a hurry.



### AIR APPLIANCE DIVISION

U.S. HOFFMAN MACHINERY CORPORATION
DEPT. CN, 105 FOURTH AVENUE
NEW YORK 3, NEW YORK

AIR APPLIANCE DIVISION

U. S. HOFFMAN MACHINERY CORP.

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Please send me at once the Hoffman Industrial Vacuum Cleaning Booklet.

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# BIGGEST

Lightweight Aggregate Kiln, anywhere



### **BUILT BY VULCAN**

Shown above are two of the largest Kilns used anywhere for the production of light-weight aggregate.

You may wonder sometimes about a large piece of machinery: wonder if the tolerances and precision work usually found in small equipment are also in the big. You've got to have it—and VULCAN has always given it. VULCAN's previous installations have had to be good for them to be in business over 100 years.

These two Kilns shown are 8' x 165'. They are designed for modern, consistent 24-hour service; and because of the strenuous duty imposed on them, are somewhat heavier than what might be called a standard design.

Every bit of equipment made by the

VULCAN IRON WORKS must measure up to the standard of quality and responsibility it has taken years to earn. You can bet that if your equipment comes from VULCAN—you'll have nothing to worry about for years.

Any information on items listed below will be sent to you immediately:

Rotary Kilns, Coolers and Dryers

Rotary Retorts, Calciners, Etc. Improved Vertical Lime Kilns Automatic Quick-Lime Hydrators

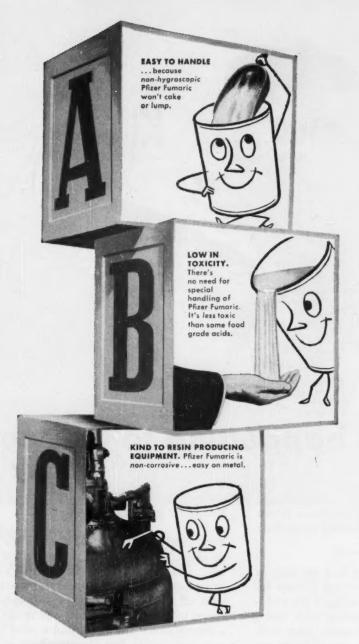
Briquetting Equipment
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Heavy Duty Electric Hoists Self-Contained Electric Hoists Cast-Steel Sheaves and Gears Diesel Locomotives Electric Locomotives and Larrys Steel Plate Fabrications Hydraulic Presses

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CABLE ADDRESS
"VULWORKS WILKESBARRE"



it's easy as ABC to use

### PFIZER FUMARIC ACID

for alkyd resins, rosin adducts, polyesters

The simplicity of using Pfizer Fumaric Acid is only one of its many advantages. It offers shorter drying time for alkyd resins, increased viscosity for rosin adducts. In purified form, it's an ideal acidulant for foods and pharmaceuticals. Write for Technical Bulletin 46 for complete information.

Manufacturing Chemists for Over 100 Years



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Chemical Sales Division
630 Flushing Ave., Brooklyn 6, N. Y.
Branch Offices: Chicago, Ill.; San Francisco, Calif.;
Vernon, Calif.; Atlanta, Ga.



### look what's happening to Culpepper

Robert E. Lee Culpepper, that is. And no finer black-eyed-pea-lover ever crossed the Mason-Dixon Line to work in a New Jersey chemical plant. He's a comer, this boy!

"Found the pace a mite fast at first up here in Yankeeland," writes Bob. "But you fellows on Chemical Engineering really brought me up-to-date fast with the Annual Inventory Issue. Got a raise and promotion since last October, next week I'm getting my own office — my super treats me like I just married the boss' daughter".

Yessuh! Young Robert is really tearing up the pea patch — taking over that plant like Grant took Richmo . . . . Oops! Well, anyway, he's doing fine

and, we understand, right in line for a Production Manager's job coming up this Fall.

Yup! North, East, South, West! They're writing us about this *Inventory Issue* from all over the busy Chemical Process Industries map. Maybe this practical, all-in-one-spot reference has already paid off for you. Or maybe you haven't gotten round to using it yet. If not, why not dust it off for a second look? You won't find a more comprehensive and usable fact-file anywhere — or a more realistic help to you on the job.

Sure, there's another one coming up in October, but let's get some mileage out of this one right now. After all, look what it's doing for Culpepper!

### ANNUAL INVENTORY ISSUE

Chemical ® ® Engineering

A McGRAW-HILL PUBLICATION, 330 WEST 42ND STREET, NEW YORK 36, N.Y.

problems in water-conditioning . . . Clarification and COLD SOFTENING

# Cochrane Solids-Contact Reactors CUT COSTS

Coagulation and clarification of surface waters, cold lime softening of well or surface waters, removal of alkalinity, silica, fluorides, etc., treatment of white water from paper to recover fibre and warm water are only a few of the many processes performed more efficiently—and at less cost—by a Cochrane Solids-Contact Reactor. Because of the Reactor's special "catalytic" design, the newly-formed precipitates plate out and grow rapidly—provide more complete reactions and produce clear water in shorter time, saving in size of the tanks employed. Chemical savings are impressive, and water waste is kept to a minimum. De-sludging is completely automatic.

Cochrane Corporation designs and manufactures every type of precipitation, ion exchange, deaeration and water conditioning equipment. To obtain equipment best suited to your requirements—consult Cochrane first!

For further information, write for publication 5001-A.

### OIL FIELD FLOODING AN APPLICATION OF COCHRANE REACTORS

Oil field flooding operations require water that is conditioned to prevent precipitates and suspended matter from plugging the oil-producing sandstone formations. Efficient flooding is assured by the Cochrane Solids-Contact Reactor shown above. Softening and clarification are combined in a single unit.

### A FEW TYPICAL COCHRANE REACTOR INSTALLATIONS

Application	Use	Capacity gph	Size Reactor Dia. H.
Oil Field Flooding	Softening & Clarification	350,000	1-72'0"x19'6"
Process Water for Papermill	Softening	378,000	1-72'0"x19'6"
Pretreatment ahead of demineralizer	Congulation	833,400	2-82'0"x17'0"
Process water for papermill	Coagulation & Softening	150,000	1-47'0"x17'0"



Cochrane

Representatives in 30 principal cities in U.S.; Toronto, Canada; Paris, France; La Spezia, Italy; Mexico City, Mexico; Havana, Cuba; Caracas, Venezuela; San Juan, Puerto Rico; Honolulu, Hawaii. Pottstown Metal Preducts Division—Custom built carbon steel and alloy

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Demineralizers • Hot Process Softeners • Hot Zeolite Softeners • Dealkalizers • Reactors • Dealerators • Continuous Blowoff Systems • Condensate

Return Systems • Specialties



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ANNUAL INVENTORY ISSUE

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Oil Field Flooding	Softening & Clarification		1-72'0"x19'6"
Process Water for Papermill	Softening	378,000	1-72'0"x19'6"
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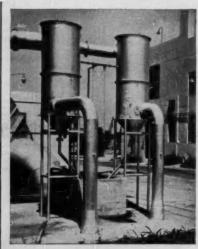
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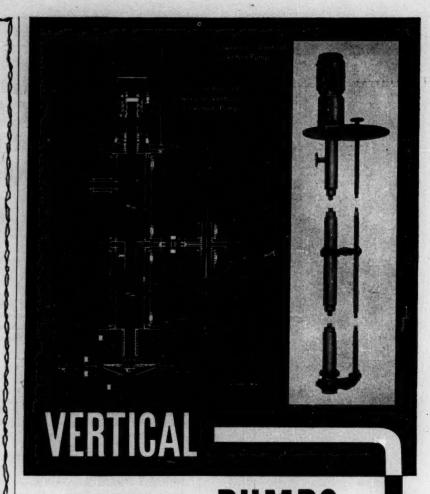
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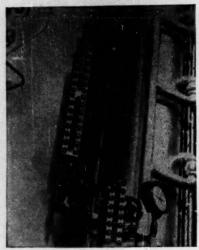
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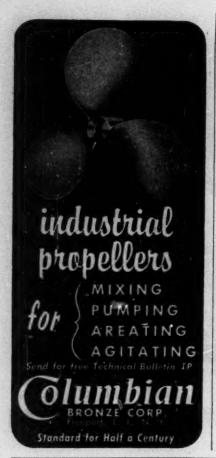
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- 1-500 gal. St. St. Evaporator, 145 sq. ft. heating coil.
- 15—Distillation, Solvent Recov- 2—Pebble Mills 6' D x 8' L. ery and Absorption Col- 20—Aluminum Tanks 500 to lumns - 8" to 72" dia -Aluminum, Copper, Steel, Stainless Steel
  - Sharples 16P St. St. Centri- 30-Agitator Drives 3 to 40 HP fuge, pressure-tite. Unused.
- 1-A.T.&M. 48" Susp. Centrifugal, Perf., St. St. Fume Tight

- 1-Stokes 3' dia. x 15' L Jacketed Rotary Vacuum Dryer
- 1-8800 gal. vacuum or Pressure Cooker with agitator and Vacuum pump, ASME
- 5-Atm. Double Drum Dryers, 22" x 38", 24" x 60", 42" x 120"
- Shriver 30" x 30" C.I. Filter Presses, open del 28 to 50ch.
- 1—Sperry 15" aluminum P & F Filter, 29 ch.
- 2-W & P 100 gal. Sigma Blade Jktd. Mixer
- 3000 gal.
- 9—Copper Tanks, 1723 to 2800 gal.
- -1200 sq. ft. Steel Shell & Tube Heat Exchangers—Un-

### **HQ. FOR STAINLESS** STEEL EQUIPMENT

USED EQUIPMENT IN STOCK

- 40—S.S. Storage Tanks from 30 gal. to 10,500 gal. sizes.
- -S.S. Pressure or Vacuum Tanks from 9 to 2600 gal.
- -S.S. Shell & Tube and coil type Condensers and Heat Exchangers from 14 to 785 sq. ft.
- -S.S. Jktd. open top Kettles from 40 gal. to 500 gal.
- -S.S. Jktd. agit. closed Reaction Kettles, 15, 50, 100, 450, 500 gal. sizes.
- 7-S.S. Side Ent. Agitators 10 HP to 25 HP.

#### CONVERTING OR CHANGING EXISTING EQUIPMENT-(Your own equipment or our stock)—Can be done in our own shops utilizing good used or surplus new materials.

FABRICATION—(IN OUR OWN SHOP)—Heliarc welding. Water-quenched stabilized welds. Large stock of type 304 and type 316 sheets and prefabricated tank sections and heads carried in stock assuring quick delivery of tanks.

Equipment Bought & Sold

Plants Liquidated



ST evenson 4-7210 Cable-PERI

1413 N. 6TH ST. PHILADELPHIA 22, PA. 

#### AGITATORS

- Alsop 5 hp. explo. proof, 420 RPM.
  Alsop 6 hp. explo. proof, 420 RPM.
  International 1 hp., 1728 RPM.
  Perter 1 hp., 420 RPM.
  Lightin 4 hp., 1725 RPM., TEFC.
  Lightin 4 hp., 1725 RPM., TEFC.
  Lightin 15 hp., 140 RPM., TEFC.
  Lightin 16 hp., 140 RPM., TEFC.
  Lightin 17 hp., 143 RPM.

#### CENTRIFUGALS & CLARIFIERS

- 2—DeLavai 84-51, 3 hp. motors.

  1—DeLavai SV454 with 10 hp. motor.

  1—DeLavai SV454 with 10 hp. motor.

  1—Fitcher 20", lithcoated perf. basket.

  1—Fitcher 12", bronze perf. basket.

  1—Tolhurst 18" suspended, st. steel.

  DRYERS
- DRYERS
  DRYERS

  Buffalo Vaccum Shelf, 5 42 x 42" shelves.

  Buffalo Vaccum Shelf, 5 42 x 42" shelves.

  3' x 24' Heading Shelf, 5 42 x 42" shelves.

  3' x 24' Heading Shelves.
  Devine #17 vaccum tray.
  Buffovas 23x90" double drum.
  Buffovas 23x90" double drum.
  Louisville 6x40' steam tube.
  Grupe \$x22' steam tube.
  Filtters

  ver 2½ x 1', iron and steel.

- Oliver 2½ x 1', iron and steel.
  Denver i x 3' vacuum retary.
  !—Oliver 8x8' stain. steel.
  !—Oliver 8x 14' iron and wood.
  !—Feinc 10'6'x 16'.
  !—Filter Pressee: cast iron, alum., wood, from 7" to 30".
  ?—Internal Pressure—Alsop, Sparkler.
  KETTLES
  !—Devine 1500 gal. jack., agit.
  !5—St. Steel jacketed, 20 to 100 gal.
  !—St. steel agitated Cookers.

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# that gives you every ADVANTAGE

Make Loeb your headquarters for the equipment value that counts in the long run of service. Our prime interest is a fully satisfied customer, not only because of the time and money saved, but in equipment performance. We'll cooperate with you all the way. If you don't see the equipment you need listed, tell us what you require.

We are always interested in purchasing your surplus equipment for cash. Send us your listings.

#### MILLS & PULVERIZERS

MILLS & PULVERIZE
Pabble: Abbe porc. lined, 215 gal.
Homoloid: Fitzpatrick mod. J., 3 hp.
3-roll Day 12 x 32, 16 x 40°.
Hammer: William Bx, 90° hp.
Hammer: Rivmond X & 90° hp.
Pulverizer: Micro 2D H., 10 hp. (New).
Pulverizer: Micro 2T H., 15 hp.
Pulverizer: Micro 2T H., 15 hp.
Poble: Hardinge buhr: lined, 5° x 36°.
Hm; Raymond X 40, 50° hp.
Colloid: Charlotte 10, st. st., 3 hp.
Colloid: Charlotte 10, st. st., 7½° hp.
Colloid: Premier U-3, 7½° hp.
Colloid: Premier U-3, 7½° hp.
Haymond X 1, 40° hp. motor.
I—Mitts & Merrill X 14 Shredder.
I—Charlotte colloid, a., 20° hp.
I—Sprout-Waldron 30° attrition.

#### MIXERS

MIXERS

4—Baker-Parkina 100 gal, Jackted.

7—Double arm sigma blade 5-100 gal.

4—Single arm sigma blade 30-100 gal.

18—Dry Powder—1½ to 77 cu. ft. cap.

3—Day, Ross 40 gal. pony.

6—Olsen & Tilgner 100-150 gal. lead-color.

1—Baker-Parkina 200 gal. Shredder.

1—Gien 120 gt. vertical.

—Revolving Drum Blender 6x6°, s.s.

I—Revolving Drum Blender 6x6', s.a.

MISCELLANEOUS

Tanks: Stain. steel up to 1200 gal.
Screens: Selectro 3-deck 4 x 16'.
Soreen: Robal 40 x 120' st, steel.
Sterilzers: Climax 20 x 36' F-22-new.
Condensers: Tubular st, sta., 16 sq. ft.
Heat Exchanger: Karbate 16.5 sq. ft.
Tubular Heater: CP, st. sta., 65 sq. ft.
Scales: Hopper batch type 50-2000 lb.
Dust Collector: Pangborn 2500 CFM.
Screens: Rotax 40 x 84'', 42 x 48''.
Pumps: Centrifugal, rotary and gear, vacuum-large steck.

TELEPHONE **SEELEY 8-1431**  EQUIPMENT SUPPLY CO.

818 W. SUPERIOR ST. CHICAGO 22

#### **Proctor & Schwartz Drying Machine**

Calmium plated perforated steel bet 7'd" wide x approximately 89' centers with oscillating stainmately 189' centers with oscillating stainmately il years old. Replacement cost \$75,000.00. Price low for immediate sale.

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#### COMPLETE BRIQUETTING PLANT

COMPLETE BRIQUETTING PLANT
One complete 8-ton per hour Briquetting
Plant complete with No. 220 "Clearfield"
mixer, alloy steel roll briquette machine,
skip hoist, troughing conveyors, and
bucket elevator. All equipment includes
drives, motors, and starting equipment,
condition good.

FS-8944, Chemical Engineering
330 W. 42 St., New York 36, N. Y.

#### BIG SAVINGS IN GUARANTEED EQUIPMENT

DRYERS & KILNS Devine #12 Vac. Sheft Dryer 47 x 42" Shelves.

1—Stakes 2' x 5' Retary Vac. Dryer.

Gon. Amer 2' x 1' Continueus Retary Vac Filter.

2—Albright-Neil 4' x 5' Atmos. Drum Dryers.

1—Buffale Vac. Drum Dryer 24' x 26'.

CENTRIFUGALS & CENTRIFUGES

-Teiburst 40" Suppended Type Centrifugals.

-Teiburst 40" Suppended Type Centrifugals.

-Centrifugals 12", 30", 40", 48" Steel, Copper, Stainless & Rubber Lined.

-Sharpice Contrifuges #5A Stainless. Alse #6, 5-Da Laval Multiple Clariflers #200, 300 & 301.

3—De Laval Muitiple Clariflers \$200, 300 & 301.
FILTES
I—Vallex 44 Stainless Covered Leaf Filter, type 49.
Sperry & Shriver 12.
Sweetland & Oliver Reary Vac. Filters.
L—Dopp 350 gal. C.I. Jack. Vac. Kettle.
Devine & Stokes Impreg. Units 30" & 36" dia.
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Kettee & Tanks. Also new Stainless.

PULVERIZERS & MILLS

2—Mikro Pulverizers #2TH #4TH.

Pattersen 30" x 42" 4 x 5' & 6' x 4' Pebble Mills.

Abbe 30" x 30" & 30" x 36" Pebble Mills.

Abbe 30" x 30" Chrome-Mang. Ball Mill.

#1 Raymond Automatic Pulverizer 20 H.P. motor.

1—Raymond #00 Pulverizer 30 H.P. Complete.

2—#0000 Raymond Mills.

Sturtovant 20. If Mingel Hammer Mill.

Jeffrey 10" x 1 & Jingle Roll Crusher.

Buchanan 6" x 12" Jaw Crusher.

Hammer Mills & Pulverizers 3 to 50 H.P.

I-Schutz-0'Neil 20' Pulverizers. Also #1.

Williams #3 & Zxx Hammer Mills.

I-Robinson 18' x 2x\* Attrition Mills.

Schutz-10' x 2x\* Attrition Mills.

Schut 3 Roll Mills 6"x32", 12"x30" & 16"x40".

1-6" x 24 3 pr. high stoel Roller Mills.

3-Houchin 18"x36", 4 Roll Granite Stone Mills.

3-Houchin 18"x36", 4 Roll Granite Stone Mills.

Bail & Jewell Rotary Cutters Lab. #1 & #2.

2-U. S. & Promier 1½ H.P. Colloid Mills.

MIXERS & SCREENS

Lancaster 6' dia. Vert. Mixer 25 H.P.

Baker Perkins deuble arm 100, 50 #9 gals.

2-Read 50 #100 gal. double arm mixers.

Kent 3 HP. Continuous Ory Mixer.

Horiz. Mixers single & double arm to 200 gal.

Read 40 and 80 et. vertical Mixers.

5-Lead & Paste Mixers 50 to 150 gals.

I-Tyler 5' x 5' Vibratory 2 Dock Sereen.

Blystone 3000# horiz, apiral mixer.

10-Dry Spiral Mixers 50 to 3000#:

12-Pertable Elec. Agitators ¼ to 3 H.P.

MISC. & SPECIAL

10—Portable Etec. Agitators ½ to 3 H.P.

13-Portable Etec. Agitators ½ to 3 H.P.

14-Portable Etec. Agitators ½ to 3 H.P.

15-Portable Etec. Agitators ½ to 3 H.P.

15-Portable Etec. Agitators ½ to 3 H.P.

16-Portable Scale Automatic Capper M.D.

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16-Portable Homop

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WAP 100 GAL WC MIXERS B&P LAB 21/4 gal MIXERS new ROBINSON 1500# S/S RIBBON MIXER LIGHTNIN 3HP PORT AGIT new SPARKLER S/S FILTER 33D17 PATTERSON 5x6 JACKETED STEEL

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MIKRO 2DH TANDEM PULVERIZERS MIKRO 3TH PULVERIZER

SPERRY 12" P&F NICKEL FILTER PRESS OTHER P&F and recessed plate FILTER

PRESSES in stock 100 S/S KETTLES from 21/4 to 125 Gal S/S OR PLAIN STEEL TANKE IN STOCK

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-5/S Merco C-30 Centrifugal Separa-tors, ea. with 100 HP TEFC motors & controls. -5/ Hersey Rotary Dryers, 5x26' and 6/23'. -2502-16 Link Belt S/S Roto-Louvre Dryer. -3'x50' Bonnot D. H. Rotary Dryers &

Coolers.

5'8''x50' D. H. Rot. Dryers.

5'8''x50' D. H. Rot. Dryers.

12'12 Sweetland Filters, 48 bronze
Monel covered lvs. 3" cc.

50 gal. Stainless 347, Calandria Still,
Agitated, with Condenser.

50 gal. Stainless 347, Agitated Tank,

1-50 gal. Stainless 347, Agitated Tank, Motor Driven.

1-Sharples #C27 Super Dehydrator, S.S. 9-Sperry 18'x18" iron recessed Filter Presses, 18 chambers.

3-450 gal. S.S. Steam Ikid. Kettles.

1-Buflovak 48"x40" Drum Flaker, chrome plated, 5/S ends.

1-Oliver Rotary Acid Filter, 8'x6'.

4-Mojonnier, S.S. Vac. Pans, 3', 5', 8'.

3-6'x50 L'ville Rot. Tube Dryers.

1-Day size 30 Imperial Jacketed 75 gal., Sigma Blades.

Sigma Blades.

27H, Mikro Pulveriser.

Buflovac Atmo. Dbl. Drum Dryers
24"x38", 32"x90", 42"x120".

Anco 4'x9' Chilling Rolls.

Horis. Ribbon Dry Mixers, 4000 lb.,
1500 lb., 500 lb.

Only a Partial Listing

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58—R. R. Type Tank Car Tanks 10,000 & 8000 Gal.

12—12,000, 15,000 & 25,000 Gal. ½ In. Horiz.

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10'x48", 8'x48", 8'x2", 6'x22", 6'x22", 6'x38", 5'x36",

3'x7', 4'x5', 4'x7', 4'x14', 5'x10', 5'x14', 5'x18',

6'x7', 6'x8', 6'x9', 6'x10', 7'x5', 7'x6', 7'x8',

8'x12', & 8'x8',

"A" ROTARY DRYERS & KILNS

3'x26', 4'x20', 4'x12', 5'x35', 8'x45', 6'x50', 9'x80',

2"-76'x35', & 4-7'x110', 8'x125', 5'x35', 9'x80',

2"-76'x35', & 4-7'x110', 8'x125', 5'x35', 9'x80',

2"-76'x35', & 4-7'x110', 8'x125', 6'x50', 9'x80',

9 AR COMPRESSORS

676, 1302, 1378', 220', 36', 8'x45', 9'x125',

676, 1302, 1378', 220', 36', 8'x45', 9'x15', 9'x15',

9 AR COMPRESSORS

12-125, 100, 80, 65, 44 & 10 Ton G. E. Diesel

Else, Locomotives.

12-125, 100, 80, 65, 44 & 10 Ton G. E. Diesel

Else, Locomotives.

14 XMMER MILLS

14 X36 Jeffrey B2 Hammermill With 75 HP

24 X36 Jeffrey B2 Hammermill With 75 HP

24 Jeffrey 42 X 35, 38' 24' 4 30 X 30,

5 Universal 30 X 30, 36 X 26 & 24 X 18.

STANHOPE, 60 E. 42nd St., N. Y. 17, N. Y.

#### For Sale

For Sale

I—Eppenbach Stainless Steel Home Mixer complete with ½ HP Explosion-Proof Motor.
2-Pramier e\* Colloid Mills, Motor Driven.
I—10" Premier Colloid Mill.
2-Motor Driven Belt Conveyors.
5-Pony Mixers, 8, 15 and 40 gal.
Itigh Speed Roller Mills 5"22" to 16"x40".
I—1 Day 4 daston non Hills 5"22" to 16"x40".
I—Eppenbach Colloid Mill, Model QV-8-1.

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#### TYPICAL ITEMS FROM OUR INVENTORY

Pfaudler Glass Lined Jacketed Reactors; 150 gal., 400 gal., 1000 gal.
Pfaudler Stainless Jacketed Agitated Reactors; 50 gal. and 75 Gal.
755 Gal. Stainless Vacuum Still, 4'6"x6' with Coils and Alum. Column 18"x15'.
Lancaster Stainless Lined Rotary Reactor; 300 PSI; Int. 50"x17'.
Struthers-Wells Stainless Vacuum Pans; 5'x12'8" with Calandria 630 sq. ft. surface; 200

Praudler Stainless Jackehed Agitated Reactors; 50 gal. and 73 Gal.

135 Gal. Stainless Vacuum Still, 40°x2° with Colis and Alum. Column 18"x15".

Lancaster Stainless Lined Rotary Reactor; 300 P51; Int. 30"x17".

30°x17".

30°x18".

Jackehed Double effact Evaporator; 60"x17" and 84"x13"6".

Swenson Quadruple Effect Evaporator; 60"x17" and 84"x13"6".

Swenson Quadruple Effect Evaporator; 60"x17" and 84"x13"6".

Swenson Quadruple Effect Evaporator; 60"x17" and 84"x13"6".

J. H. Day Jacketed Double Ribbon Blender; Sixe 30"x78"x34" with 10 HP motor.

Parterson Stainless Conical Tumbling Mixer; 64 cu. ft. with 7½ HP XPL motor.

Reacdo 210 gal. Jacketed Heavy Duty Double Ribbon Mixer; 30"x68".

Sprout Waldron Stainless Ribbon Mixer; 60 mixer; 100 gal. working.

Sprout Waldron Stainless Ribbon Mixer; 60 mixer; 100 gal. working.

Stainless Tumbling Barrel Mixer, 5"x5"; baffled Interior; 31 MP.

Simpson Intensive Muller Type Mixer, Model '0"; 36"x15"; Jacketed.

Stainless Trumbling Barrel Mixer, 5"x5"; baffled Interior; 31 HP.

Simpson Intensive Muller Type Mixer, Model '0"; 36"x15"; Jacketed.

Stainless Steel Bubble Cap; 60 plates; 27!/y" dia. x 36' high.

Dopp Cast Iron Jacketed and Agitated Kettles; 630 gal.; 61"x68".

Bethlehem Cast Iron Sulphonator; 79"x743/"; with Colis in Jacket.

Grylles Simpson Rotes Sitters; 21"x69"; 31"x69" x60"x60".

Robinson Unique Gyro Sitters; 20"x69", 60"x60", 60"x60".

Robinson Unique Gyro Sitters; 30"x60", 60"x60", 70"x60".

Wilthe Stainless Steel Sterry; 10"x69"; 11"x60" and 21"x10", complete.

A. O. Smith; Stainless Lined Pressure Tanks; 135 P51; 10"x30".

Robinson Unique Gyro Sitters; 21"x69"; 21"x69"; 30"x60", 30"x60".

Shriver & Sperry Stainless Lined Pressure Tanks; 135 P51; 10"x30".

Shriver & Sperry Stainless Filter Presses; 12" and 18".

Shriver & Sperry Stainless Filter Presses; 12" and 18".

Shriver & Sperry Stainless Filter Presses; 12" and 18".

Shriver & Sperry Stainless Filter Presses; 12" and 18".

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FULLY GUARANTEED



- ★ 32x32, RCGH, Roots-Connersville Gas, Pump 14,000 cfm @ 7½#—New in 1950
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STEEL PLATE EXHAUSTERS



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### FOR BEST BUYS

- 1—Blaw-Knox 110 Gal. Jacketed Agitated Autoclave—200# Pressure.
- -Davis Inconel Heat Exch. 195 Sq. Ft. 8—Devine Surface Condensers-Receivers 100 to 175 Sq. Ft.
- -Carrier 8 Truck Dryer-Glass En. Trays.
- 7-Devine Double Dr. Vac. Shelf Dryers.
- 1-4x9 Double Drum Atmos. Dryer. 8-12" to 42" C.I. Filter Presses.
- 2-Sweetland #10 & #12 Filters.
- 1-Pf. 100 Gal. G.L. Reactor.
- 2—Jack. Kettles Glass Lined 750 and 100 Gals.
- 4-W & P 100 and 200 Gal. Double Arm 3-Rotex Screens 20 x 48 to 40" x 120".
- 3—Stainless Steel Tanks 2100 & 4000 Gals. W/S.S. Coils.
- 1—Buflovak Double Effect Evaporator, Stainless Steel.

Send for Bulletin A-34 with complete listings.

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The MACHINERY & EQUIPMENT Corp.

Harry Pearlman, Pres. - Bill Welf, Vice-Pres.

#### Used equipment available PROMPT SALE

1-36" Oliver Filter 1-30" ID x 6' deep Paint Mixer with water cooled -30" ID x 6" deep raint minut with the cone pattern Mixer Tanks—cone shaped bottom tapered to 12" Dia. outlet. FS-6432. Chemical Engineering 520 No. Michigan Ava., Chicago 11, 111.

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#### BUY "GUARANTEED RELAYERS"

Handle more cars better - spend less to install & maintain with Foster Relayers. "Open-stock" shipments, all sections 12# thru 175# Switch Materials, Track items. Send catalogs Rails Track Equipment
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#### **EQUIPONOMICS**

BIRD CONT. CENTRIFUGE—36" x 50", S.S. 304 CENTRIFUGE—ATM Suspended, Steel, 48" complete with 40 H.P. TEFC motor, 2 sp. DRYER, Buralo, double drum, 32" dia. x 90".

Reconditioned. KETTLES, G/L Pfaudier, 200, 300, 500, and 1000

### IMMEDIATELY AVAILABLE

CENTRIFUGES—40" Fletcher, SS, Sus-pended bottom discharge, 15 HP. 40" Tolhurst steel, Susp., bottom dis-

charge. 20" Tolhurst, SS, underdriven, perf. basket.
CHURN—B. P. wet, complete.
COLUMNS—72"x29'8" SS 347, welded,

21 trays.

19"x23' Karbate #22 packed, NEW. 5'x23' Everdur. 5'x18' SS 347 lined. COMPRESSORS — York 310 ton Freon

1800 CFM, I.R. PRE-2, 300 HP, 100 PSI.

1800 CFM, I.R. PRE-2, 300 HP, 100 PSI. 327 CFM, I.R. Imperial, 60 HP, 100 PSI. CONDENSERS—3400 sq. ft. 150 PSI. Steel. 220 sq. ft. 85 316 tubes 200 PSI. 1800 sq. ft. St. 316 tubes 200 PSI. 1800 sq. ft. St. 347, 2 pass shell 40 PSI, 6 pass tubes 60 PSI. NEW. DRYERS—30"x8' Rotary Vac., Complete. 5'x15' Rotary Vac., jkt'd., 20% nickel clad. 5'x6' single drum, atmospheric. EXTRUDER—Weld. Eng. Type B3AWEZO SS screw.

SS screw. FILTERS—8'x12' Feinc, steel, string disch.

FILTERS—8'x12' Feinc, steel, string disch.
8'x10' Oliver, steel & wood, agitated.
Bowser #3 Everdur tank, SS screens.
Sweetland #5, SS lined, hyd. close.
KILNS—502-20 & 604-20 Roto Louvres.
34"x16'6", 4'x20', 4'x42', 5'x24', 5'x67',
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paddle. 300 gal. B.P. 18-DIM, SS dbl. arm. 100 gal. B.P., jkt'd., double arm tilt. 50 gal. W&P Size 14BB, double sigma, tilt. TANKS—Storage & Pressure, 200 gal. to 25,000 bbl.

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- Ail items listed subject to prior sale or use by Eli Lilly and Company.
- 9 Podbielniak, Type 316 S.S. centrifugal, multistage, counter-current liquid-liquid solvent extractors. 1 Serial #6060, 8 Serial #6070, Engineering data available. Original cost 1947—\$12,500 ec. Used. PRICE \$2,500 ea.
- Buffalo Vac 12" x 18" Drum Drier S.S. Blade and Drum. Used. PRICE \$1,500
- Blade and Drum. Used. PRICE \$1,300

  3 Devine single door vacuum shelf driers. 6
  shelves, 9" apart. 80 square feet effective
  pan surface. Drawing available. Replacement cost \$5,500 ea.

  1 Dean Brothers Pump 7 x 7 x 10 Duplex
  Double Acting Piston Type Pump. Durable
  S.S. Valve Service. Replacement cost \$1,200.

  New. PRICE \$600
- 3 Polar Stills, 3 Rotameters, 1 Tapered Tantalum condensor, 1 Copper condensor 24 square feet, 1 Tilting Kettle on casters 200 gallon.

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- Pfaudler 1,000 gal. Glasslined Jacketed Reactor, Series R. (New)
- -Pfaudler 50 gallon glass lined vacuum receivers (New).
- Nooter steel jacketed vacuum kettle 750 gallons.
- -Piaudler Glass-lined Storage Tank, 1,000 gallons.
- Patterson-Kelly Steel Jacketed Kettle, 1500 gallons, ASME.
- 1-Plate Fabricators 6.000 gallon Jacketed Kettle.
- 1-Pflaudler 150 gallon Stainless Steel Jacketed Kettle with Anchor type agi-
- -Groen Stainless Steel Jacketed Kettle,
- 40 gallons, with agitator.

  —Stainless Steel Jacketed Agitated
  Vacuum Kettles 650 gal.
- 12—Koven Stainless Steel Jacketed Vac-uum Kettles, 380 Gals. Cap. Each.

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- 2—Sharples S.S. super pressurite contri-fuges. Model 16.
- Sharples Type 316 Stainless Steel Centrifuge, Model D2.
- -DeLaval Type 316 Stainless Steel Multi-Matic Centrifuge.
- -Fletcher S.S. Suspended Type Centri-fuge, 40" Perforated Basket.
- -A. T. & M. Stainless Steel Susp. Centrifuges, 48" Imperforated Basket.

#### DRYERS-KILNS

- 2-Buflovak single door vacuum shelf dryers, 20 shelves.
- Devine single door vacuum shelf dryers, 10 shelves.
- Devine laboratory vacuum shelf dryer with 3 S.S. shelves (New).
- -3' x 12' Stainless Steel Rotary Vacuum dryer.

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  Stokes Rotary Vacuum Dryer, 30" x 8'. Buflovak 32' x 90" Double Drum Dryer
- Complete.
- 1-Allis Chalmers 28" x 60" Double Drum Dryer.

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- 1—Shriver C.I. Plate and Frame, 2 eye, open delivery Filter Press 42" x 42", 54 chambers.
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- -30" x 30". -Sperry 42" Filter Press Skeleton with hydraulic closing device (New).

  Sperry Wooden Plate and Frame
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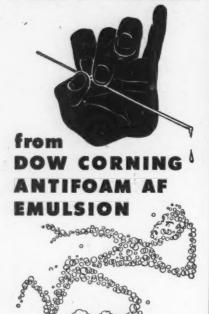
- Oliver Rubber Lined Pressure Filter, 3' x 6'. (Complete)
- -Filtration Engineers Type 316 S.S. Rotary Vac. Filter, string discharge, size 6'6" x 6'. (New)
- -Filtration Engineers Type 304 S.S. Rotary Vac. Filter, string discharge, size 5' x 3'. (New)
- -Filtration Engineers Type 304 S.S. Rotary Vac. Filters, string discharge, 3' x 3'. (New)

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- 1-Banbury Lab. Size Mixer, complete with motor.
- International S.S. Double Ribbon Bender, 50 cu. ft.
- 4-Lightnin' Side Entering Mixers, 20 HP, explosion-proof 425 RPM.
- Baker Perkins Steel Double Arm, Sigma Blade Mixer, 20 gal.
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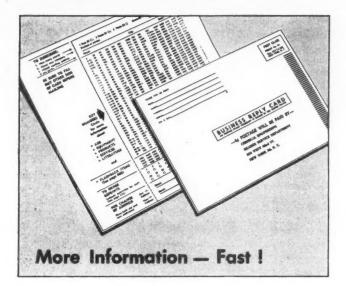
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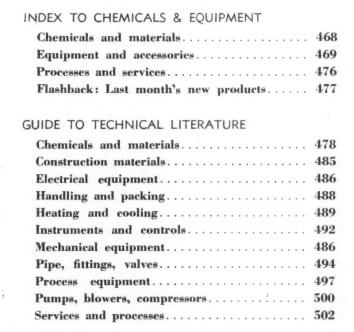
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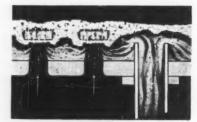
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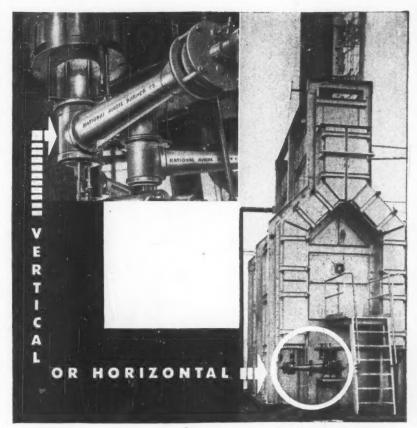
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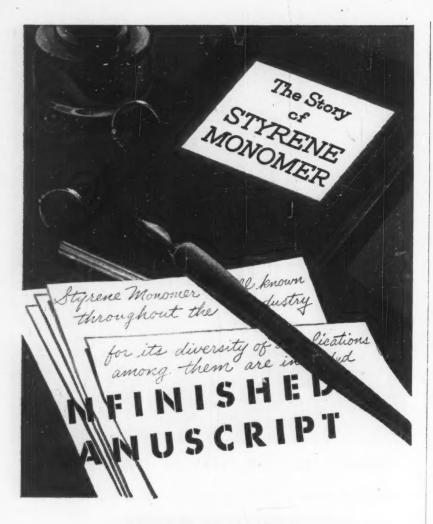
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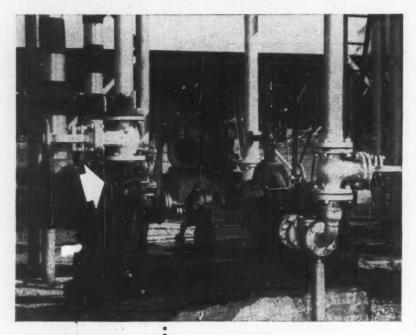
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Materials of construction, clad steels       26b         Materials handling       73c         Bulk       100-1         Metals, platinum clad       266-7b         Meters       Flow       310B         Positive displacement, bulletin M-152       505         Mills       Ball       158a         Catalog 100       158a         Bulletin C5C-B       475b         Grinding       150g         Hammer       287c         Helix-seal       287d         Ring-roll       76e         Roller       287e
Materials of construction, clad steels       26b         Materials handling       73c         Bulk       100-1         Metals, platinum clad       266-7b         Meters       Flow       310B         Positive displacement, bulletin M-152       505         Mills       Ball       158a         Catalog 100       158a       475b         Grinding       150g       475b         Grinding       150g       480g         Hammer       287c       480g         Helix-seal       287c       287c         Ring-roll       76e       76e         Roller       287e         Mixers       TR411b         Catalog 79       158b
Materials of construction, clad steels       26b         Materials handling       73c         Bulk       100-1         Metals, platinum clad       266-7b         Meters       310B         Positive displacement, bulletin M-152       505         Mills       Ball         Catalog 100       158a         Bulletin C5C-B       475b         Grinding       150g         Hammer       287c         Helix-seal       287c         Ring-roll       76e         Roller       287e         Mixers       TR411b         Catalog 79       158b         Data sheet B-107       257a
Materials of construction, clad steels       26b         Materials handling       73c         Bulk       100-1         Metals, platinum clad       266-7b         Meters       Flow       310B         Positive displacement, bulletin M-152       505         Mills       Ball       158a         Catalog 100       158a       475b         Grinding       150g       475b         Grinding       150g       480         Hammer       287c       480         Helix-seal       287c       76c         Roller       287e       78c         Mixers       TR411b       Catalog 79       158b         Data sheet B-107       257a       Catalog B-109       257h
Materials of construction, clad steels         26b           Materials handling         73c           Bulk         100-1           Metals, platinum clad         266-7b           Meters         Flow         310B           Positive displacement, bulletin M-152         505           Mills         Ball         Catalog 100         158a           Bulletin C5C-B         475b         Grinding         150g           Hammer         287c         Helix-seal         287c           Helix-seal         287c         Roller         287e           Mixers         TR411b         Catalog 79         158b           Data sheet B-107         257a         Catalog B-109         257h           Dispersall, catalog 68         414
Materials of construction, clad steels         26b           Materials handling         73c           Bulk         100-1           Metals, platinum clad         266-7b           Meters         Flow         310B           Positive displacement, bulletin M-152         505           Mills         Ball         Catalog 100         158a           Bulletin C5C-B         475b           Grinding         150g         Hammer         287c           Helix-seal         287d         Ring-roll         76e           Roller         287e         Mixers         TR411b           Catalog 79         158b         Data sheet B-107         257a           Catalog B-109         257h         Dispersall, catalog 68         414           Horizontal, batch         73a           Laboratory,         10c         10c         10c
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Materials of construction, clad steels         26b           Materials handling         73c           Bulk         100-1           Metals, platinum clad         266-7b           Metals, platinum clad         310B           Positive displacement, bulletin M-152         505           Mills         Ball           Catalog 100         158a           Bulletin C5C-B         475b           Grinding         150g           Hammer         287c           Helix-seal         287c           Ring-roll         76e           Roller         287e           Mixers         TR411b           Catalog 79         158b           Data sheet B-107         257a           Catalog B-109         257h           Dispersall, catalog 68         414           Horizontal, batch         73a           Laboratory,         catalogs DH-50 & DH-51         257f           Mulling, book 522         289
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Materials of construction, clad steels         26b           Materials handling         73c           Bulk         100-1           Metals, platinum clad         266-7b           Meters         Flow         310B           Positive displacement, bulletin M-152         505           Mills         Ball         158a           Catalog 100         158a           Bulletin C5C-B         475b           Grinding         150g           Hammer         287c           Helix-seal         287c           Ring-roll         76e           Roller         287e           Mixers         TR411b           Catalog 79         158b           Data sheet B-107         257a           Catalog B-109         257h           Dispersall, catalog 68         414           Horizontal, batch         73a           Laboratory, catalogs DH-50 & DH-51         257f           Mulling, book 522         289           Portable         Bulletin         74-A         158e
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## Flashback

To make sure that you don't miss any news that could help you with your job, Chemical Engineering is doing a double take for you. The index below repeats the editorial listings only on chemicals, equipment and service featured last month in New Equipment and in Chemicals and Raw Materials. Use the postcard (p. 511) for more information on any items.

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#### What It Contains . . .

This is a comprehensive listing of the latest literature you can now get from manufacturers on chemicals, equipment and services in all fields of interest to chemical engineers. It lists new publications just released, in addition to technical literature mentioned in the advertisements in this issue. The latter are identified by an asterisk (\*) along-side the company name.

#### For More Information . . .

You can get—and get fast—more information on any publication listed in this guide by using the Reader Service post-card inside the back cover. Simply circle the item's code number on the postcard, fill in your name and address, then mail to us. Ask for as many as you need. Answers come to you direct from the companies putting out the literature.

#### 

## **Guide to Technical Literature**

Want to build up your files and keep them up-to-date?

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#### Chemicals

- Acetonitrile.....Versatile solvent for coatings—synthetic fibers—fats and olls processing... reactive intermediate for pharmaceuticals and other chemicals. Data on solvent properties and chemical reactivity.

  478A Carbide & Carbon Chem.
- Acetyl Tributyl Citrate.....Now you can get dor-free Citroflex A-4 (acetyl tributyl citrate)...a plasticizer with an extremely low order of toxicity. Features many applications. Literature & product sample. 478B Chas. Pfizer & Co.
- Acid, Acetic.....Eastman acetic acid—
  organic synthesis...reaction medium
  and solvent...dyeing assistant...
  etc. Company makes available upon
  request detailed information and product samples.
  4786 Eastman Chem. Products.
- Acid Anhydrous, Hydrofluoric . . . . . 40 p. book contains valuable information concerning hydrofluoric acid anhydrous. Provides useful data for those who now use HF, or for those who are contemplating its use.

  \*Harshaw Chem. Co.
- Acid, Asciaic..... Economic replacement for high-priced dibasic acids has unlimited potential use in plasticizers, alkyd resins, polyesters, polyamides & synthetic lubricants. Sample & descriptive technical literature. 478D Emery Industries.
- Acid, Itaconic.....Two carboxyl groups, a conjugated double bond and an active methylene group make Pfizer itaconic acid a reactive and versatile molecule. Offers Technical Bulletin No. 82 plus one-lb. sample.

  478E Chas. Pfizer & Co.
- Acid, Phosphoric . . . . Chemical of a thousand uses . . . AA Quality phosphoric acid, in its various grades, amply & consistently meets national formulary & pure food specifications. Data Sheet offers full details.

  478F American Agricultural Chem.
- Acids, Fatty.....Coconut oil fatty acids feature controlled chemical composition... so you get better & easier control during processing—plus a better, more uniform end product. Samples & specifications.

  478G El Dorado Oil Wks.
- Alcohol, Propargyl.....Three centers of reactivity. Chemical intermediate for pharmaceuticals, agricultural chemicals, etc. Corrosion inhibitor & stabilizer for halogenated compounds. Sample & technical information.

  478H General Aniline & Film Corp.
- Alkanolamides, Fatty . . . . . Announces publication of "The Fatty Alkanolamides—Emcol 5000 Series." Describes properties, uses & many formulations for this broad series of products. Technical Bulletin No. 44.

- Alkyds, Flat.....New Brochure on FAFL—the alkyl for flats. Provides technical data on vehicle, & in addition a variety of suggested formulations for alkyd flat paints in white & colors. Also product samples.

  4783 Farnow, Inc.
- Alumina, Activated.....Reynolds activated alumina dries to lowest dew points of any commercial dessicant. It is inert, easily reactivated, non-deliquescent and will not swell or disintegrate. Full data and samples.

  478K Reynolds Metals Co.
- Amines, Secondary . . . . Describes
  Armeen 2S and Armeen 2T—new (unsaturated) secondary amines, of particular interest in corrosion inhibition
  problems in oil systems. Request Market Development Technical Bulletin.

  478L Armour Chem. Div.
- Amines, Secondary.....Du Pont Sarcosine—a clear, aqueous solution of the sodium sait. It combines both basic and acidic properties . . . may have a faint odor of amine. Request literature and product samples. 478M E. I. du Pont de Nemours.
- Amines, Tertiary . . . . . Armeen DMS, DM16 & Armeen DM18—new tertiary amines (dimethyl soya, dimethyl palmityl & dimethyl stearyl) for evaluation in fields of sanitation, textile chemicals, etc. Tech. Bulletin.

  478N Armour Chem. Div.
- Aminoethyl Ethanolamine.....A hygroscopic liquid with a medium viscosity and a mild, ammoniacal odor. Describes applications, physical properties, specifications, handling precautions, etc., in Booklet No. F-6455A. 4780 Carbide & Carbon Chem.
- Amproxyme.....Contains high potency standardized amylolytic (starch solubilizing) enzymes used in breakdown of starch paste, solubilization of starch matter, removal of starch size from fabric. Data & test sample.

  478Q Jacques Wolf & Co.
- 2-Butyne-1,4-Diol . . . . . A synthetic building block and corrosion inhibitor. White solid, m.p. 57.5°C, b.p. 140°C (10 mm.). Also available as 35% aqueous solution. Offers product sample and technical information. 478B General Aniline & Film Corp.
- n-Butyraldehyde.....Eastman n-butyraldehyde—chemical intermediate ... plastic intermediate ... pharmaceutcal intermediate ... etc. Furnishes complete product, information in addition to samples. 4788 Eastman Chem. Products
- Calcium Boride.....Suggested uses:
  preparation of calcium boride parts
  by powder metallurgy techniques; as
  a boriding agent with metal powders;
  solid propellant mixtures; etc. Request Technical Bulletin.
  478T Metal Hydrides.
- Calcium Carragheen Sulfates.....Gelloids are thoroughly-refined, purified, standardized extracts of Irish Moss —eliminate danger of syneresis & hydrolysis in almost all formulations, Samples & information. 478U Jacques Wolf & Co.

- Capsules, Seamless.....Brochure covers new Gunnell capsules: what they are —how they are made—what sizes are available—the advantages—present capacity—availability of samples packaging information—etc. 479A Gunnell Capsulations.
- Carriers, Dye.....Presents a Technical Bulletin discussing applications of the new Tanalon dye carriers, which are said to permit even dyeing of Dacron and its blends, without spotting, staining, or tarring.

  479B

  Tanatex Corp.
- Catalysts.....You benefit with Girdler catalysts: custom design matches your needs; technical service helps you save; quality control assures uniformity; etc. For complete information, request Bulletin G-260. 393 \*Girdler Co.
- Chemicals......44 p. Catalogue lists company's many products and briefly describes their chemical and physical properties. Covers detergents, wetting agents, emulsifiers, brighteners, dyeing assistants, etc.

  479D

  Antara Chem.
- Chemicals . . . . . Mallinckrodt's flexible production facilities are geared to precision manufacture of chemicals from a few tons to carload lots. Brochure lists and describes company's chemicals and their uses.

  479E Mallinckrodt Chem. Wks.
- Chemicals.....With the addition of Fair-field Chemical, there are now six FMC Chemical Divisions. Detailed information on their activities contained in fully illustrated brochure, "Putting Ideas to Work."

  479F Food Machy. & Chem. Corp.
- Chemicals, Industrial.....Illustrated, 16
  p. covers: preformed catalysts, catalytic chemicals: electroplating salts, anodes & processes; fluorides; driers & metal soaps; pigments; etc. Request Booklet No. D-2794.
  479H Harshaw Chem. Co.
- Chemicals, Molybdenum......Molybdenum compounds are widely used in production of catalysts, phosphomolybdic-phosphotungstic lake colors, molybdate chrome orange pigments, etc. Technical data, samples, prices.

  4791 J. T. Baker Chem. Co.
- Cobalt Compounds......Valuable information on cobalt as a nutritional corrective in animals—a compilation of articles bearing on the importance of cobalt in relation to nutrition. Illustrated Booklet D 1995.

  479J Harshaw Chem. Co.
- Cobalt Hydrate......Witco manufactures cobalt hydrate as a highly reactive source of cobalt for the synthesis of cobalt-containing compounds. Includes typical analysis in Technical Service Bulletin No. P-19.

  479K Witco Chem. Co.
- Color Paste Concentrates . . . . . Makes available a reference describing "4000" series color paste concentrates . . . for coloring epoxy, thickol, polyurethane isocyanate resin. Technical Bulletin No. 130. 479L Claremont Pigment Dispersion.
- Defoamers.....For more efficient foam control. Versatile defoamers save space now wasted on foam, cut the processing time, elminate waste & fire hazard of overflowing foam, etc. Offers complete data & samples.

  1.466 \*Dow Corning Corp.

\* See explanation on p. 478



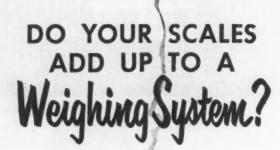


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#### LITERATURE . . .

- Detergents, Spray-Dried.....Neopone LO
  is new low foaming non-ionic spraydried detergent...specifically formulated for use in automatic laundry
  machines. Available for immediate
  shipment. Data & samples.
  480A Ultra Chem. Wks.
- Dibutyl Fumarate..... A reactive resin & chemical intermediate—available in semi-commercial quantities. Covers typical physical properties, polymerization reactions, toxicity, etc. Technical Bulletin ODB-54-18.

  480B Monsanto Chem. Co.
- Dimethyl Sulfoxide.....A new solvent with numerous unusual advantages. Clear, water-white, very hygroscopic and completely water soluble liquid... now available in pilot plant quantities. Complete information.

  480C Stepan Chem. Co.
- Dispersing Agents.....Darvan #1 and #2—polymerized organic saits of sul-fonic acids (alkyl-aryl type)...they are true dispersing agents for water systems. Makes available data and product sample upon request. 480D R. T. Vanderbilt Co.
- Driers.....Illustrated, 24 p. covers chemical properties of driers (cobalt, lead, manganese, zinc, calcium, iron, copper) & physical properties (naphthenic driers, octoic driers, etc.). Bulletin 54-2.

  Witco Chem. Co.
- Dyes, Resin Fast.....Better color fast-ness in resin-treated fabrics now is possible ... with Cyanamid's line of Calcodur Resin Fast Dyes. Announces availability of valuable literature & product samples. 24-5b \*American Cyanamid Co.
- Epoxidation-Hydroxylation Reactions
  .....Makes available a reprint of an article which discusses epoxidation reactions and the importance of the reaction products for the plastics industry. Request Bulletin 58.

  480G Buffalo Electro-Chem. Co.
- Ethylene Glycol Monobutyl Ether.....

  Solvent in: nitrocellulose lacquers—
  to improve blush resistance & promote
  good flow out & gloss; baking enamels
  —as a viscosity-reducing agent; etc.
  Bulletin F-7862.

  480H Carbide & Carbon Chem.
- Fillers......Furafil 100 is a filler for phenolic resin molding compounds & molded rubber articles & an anticaking agent & carrier in insecticide & fungicide compositions. Bulletin 133 & product samples on request.

  4801 Quaker Oats Co.
- Formaldehyde in Alcohols.....Celanese
  Formcels are relatively water-free
  formaldehyde solutions in a variety of
  alcohols offered to meet individual
  requirements. Full details in New
  Product Bulletin N-23-4A.
  480J Celanese Corp. of America.
- Furfural.....Rely on furfural for performance ... uniform purity ... low cost ... unfailing availability. Offers test sample & descriptive Bulletin (204) covering its unusual properties and numerous uses.

  486 \*Quaker Oats Co.
- Gelling Agents.....Sodium Stearate T-1 & Aluminum Stearate #22 have found new application in rapidly growing field of vinyl plastisols and organosols. Valuable data in Technical Service Bulletin G-5. Witco Chem. Co.
- cerine.....Offers valuable booklets including: "Glycerine Alkyds Tailored to Need" (20 p.); reference on glycer-ine standards & specifications (12 p.); booklet covering properties & applica-tions (16 p). 95 "Glycerine Producers' Assoc.

<sup>\*</sup> See explanation on p. 478

- Glycois.....High purity ethylene glycois are extremely versatile with a wide range of applications. Actual shipping analyses show low iron, low chlorides, low acidity, low water. Request product sample & data. 481A Nitrogen Div., AC&D
- Hexachlorophene.....Sindar announces the release of a comprehensive bibliography of literature covering the subject of their G-11 brand of hexachlorophene. Contains 136 references. Technical Bulletin No. H-1. 481B Sindar Corp.
- Hexamethylenetetramine . . . . . Specifications of technical grade hexamethylenetetramine: purity 99.5 % formaldehyde none; ammonia 0.02% max.; chlorides—0.02% max.; ash—0.05% max.; etc. Samples on request.

  481D Borden Co.
- Hexanetriol-1,2,6,.....A new long chain polyol for ... polyurethane resins & isocyanate foams ... modified alkyd resins ... humectant-plasticizer applications ... etc. Request Technical Bulletin F-7779.

  141 \*\*Carbide & Carbon Chem.
- Hydrogen Peroxide.....High density pulp bleaching processes—describes use of hydrogen peroxide in steep bleaching, continuous tower bleaching, dryer bleaching, etc., as applicable to various pulps. Bulletin 48.

  481E Buffalo Electro-Chem. Co.
- Hydroquinone, Technical.....As a reducing agent . . . or chemical intermediate . . . you will find Tecquinon (Eastman technical hydroquinone) a versatile processing tool. Makes available sample quantities.

  481F Eastman Chem. Products.
- Hydroxyadipaldehyde.....Because hydroxyadipaldehyde is a dialdehyde, its largest application is in the cross-linking and insolubilization of proteins and polyhydroxy compounds. Offers descriptive literature.

  4816 Carbide & Carbon Chem.
- 12-Hydroxystearin.....Presents technical data on Castorwax 12-hydroxystearin. Gives valuable explanation on where and why low-cost Castorwax is used. Includes formulation information. Technical Bulletin No. 7.

  481H Baker Castor Oil Co.
- Insecticide Ingredients.....Fatal for flies & mosquitoes—many municipalities & agencies concerned with pest control use Thanite-DDT formulations to rid areas of insect pests. Booklet covers properties & uses.

  4811 Hercules Powder Co.
- Ketones, Fatty.....Furnishes valuable information on Laurone, Stearone and Oleone—fatty ketones, for use in petroleum waxes, and anti-block compounds. Request your copy of Market Development Technical Bulletin.

  4814 Armour Chem. Div.
- Lignin.....Indulin (pine wood lignin) is an inexpensive sequestering agent for calcium & magnesium ions in neutral to mildly alkaline solutions. Makes available product samples & Technical Bulletins Nos. 107 & 108. 481K West Va. Pulp & Paper Cb.
- Lithium Carbonate.....Product has had its greatest use in the ceramic and chemical manufacturing fields. Announces the availability of a Data Sheet describing density, solubility, typical analysis, uses, etc.

  481L Lithium Corp. of America.
- Magnesium Aluminum Silicate.....Veegum...a purified magnesium aluminum silicate with thixotropic properties...permits higher solids suspensions at lower viscosities. Provides information and product sample.

  481M R. T. Vanderbilt Co.

• See explanation on p. 478



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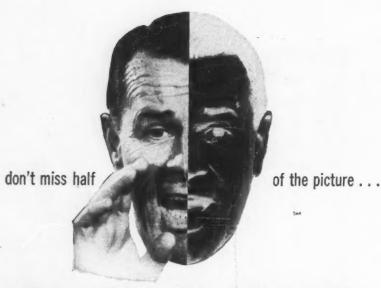
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#### LITERATURE . . .

- Methylcyclohexanol..... Is a cyclic alcohol solvent having wide uses in the paint, plastics and textile industries. New Data Sheet covers typical physical properties, solvent action, suggested uses, etc.

  482.4

  Howards & Sons.
- Molybdenum Pentachloride . . . . Reference covers the more important physical & chemical properties of chemically pure molybdenum pentachloride. Also describes preparation of compound. Bulletin Cdb-3.

  482B Climax Molybdenum Co.
- Napthas, Heavy
  naphthas contain methyl naphthelenes & have good solvency for insecticides such as DDT, 2,4-D esters, & chlorinated camphene. Complete specifications & product samples.

  482C Pennsylvania Indus. Chem.
- Oils, Essential.....Company announces the availability upon request of their Price Catalog. Valuable reference contains price information for line of essential oils, aromatic chemicals & certified colors.

  482D Dodge & Olcott.
- Paraffins, Choirinated . . . . Bulletin contains suggested flame retardant rubber recipes which illustrate use of Chlorowax 40 & Chlorowax 70, chlorine bearing hydrocarbons. Covers physical & chemical properties.

  482E Diamond Alkali Co.
- Peroxygen Compounds . . . . . Reference deals in great detail with chemical polishing processes for steel, aluminum and brass, surface cleaning and surface passivating procedures. Ten references. Bulletin No. 51.

  482F Buffalo Electro-Chem. Co.
- Phosphorus Pentasulfide.....Widely used in making lubricant additives, it is one of many phosphorus products carrying AA Quality seal—symbol of highest quality & uniformity. Furnishes information & samples. 482G American Agricultural Chem.
- Plasticizers . . . . . 76 p. includes selector chart based on compatibility, physical properties & descriptions of Flexol plasticizers, & discussion of relation of physical properties to performance characteristics.

  482 H Carbide & Carbon Chem.
- Plasticizers..... Hatco plasticizers are distinguished for their high purity and superior stability. Reference covers uses for plasticizers, specifications, physical properties of pure compounds, etc. 8 p.

  Hatco Chem. Co.
- Plasticizers, Catalytic......Crumbled batches of oil-extended GR-S stocks can be avoided by using Pepton 22 catalytic plasticizer for GR-S and natural rubber. Literature and product samples available on request. 24-5f \*\*American-Cyanamid Co.
- Polyacrylamide.....Stable under all pH conditions . a versatile thickener for aqueous systems such as rubber & paint latics, ceramic slips, metal cleaners & adhesives. Literature & product samples.

  24-5a \*American Cyanamid Co.
- Polybutenes..... Feature valuable advantages: high viscosity; minimum thermal decomposition residue; non-drying; color stable; non-migrating; low cost; etc. For details, request Technical Bulletin No. 12.

  482J Indoil Chem. Co.
- Potassium Acid Saccharate.....This monopotassium salt of a polyhydroxy di-basic acid offers vast opportunities in the manufacture of industrials and pharmaceuticals. Samples and information available on request.

  482K Sanders Chem. Co.
- Potassium Carbonate......Potassium carbonate now available in 91-94% powdered form... for faster dissolving—for better compounding. Inspection samples and descriptive information sent upon request.

  145 \*Solvay Process Div.

June 1955—CHEMICAL ENGINEERING

\* See explanation on p. 478

- Propargy! Halides.....Three centers of reactivity. Chemical intermediate for terpenes and pharmaceuticals, etc. Agricultural uses as soil fumigant, etc. Request technical information, price schedules, product sample.

  483A General Aniline & Film Corp.
- Protozyme.....Contains high potency standardized proteolytic or protein de-grading enzymes. Choice for breaking up peptides, solubilizing albuminous substances, removing gelatine from film, etc. Data & sample. 483B Jacques Wolf & Co.
- Quaternary Ammonium Compounds......
  Covers Arquad 2T—a quaternary ammonium salt of Armeen 2T, useful in corrosion problems & as a cationic emulsifier & anti-static agent. Market Development Technical Bulletin.

  483C Armour Chem. Div.
- Reagents Laboratory......Announces new 1955 Products Book...a 266 p. illustrated guide to services, products and special facilities of the foremost producer of laboratory reagents and fine chemicals. 147a \*Baker & Adamson Products.
- Resins..... A superior resin, Exon 468 offers good heat and light stability, high thermoplasticity, compatibility with conventional vinyl plasticizers, stabilizers and pigments, Complete information. \*Firestone Plastics Co.
- Resins, Acrylic.....Lucite acrylic resins available with a wide range of molding characteristics & properties & in a variety of transparent, translucent & opaque colors. Offers descriptive literature on request.

  151a \*E. I. du Pont de Nemours.
- Resins, Casting..... Stycast 2340 M is a two part casting resin requiring no catalyst addition. Reference includes a general description, properties, and instructions for curing, Request Technical Bulletin No. 7-2-8.

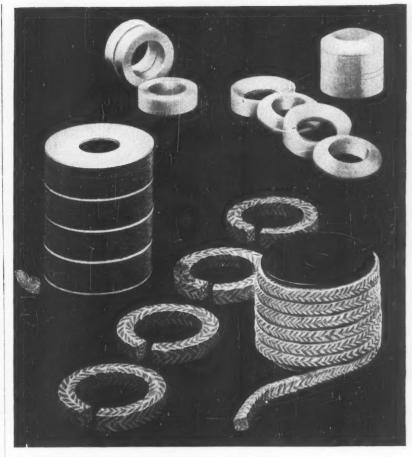
  483D Emerson & Cuming.
- ins, Nylon.....Zytel is the du Pont trade-mark for a versatile group of long-chain synthetic polymeric amides exhibiting extreme toughness & strength. Completé data on properties & applications on request. pplications on request.

  \*E. I. du Pont de Nemours.
- Resins. Para Coumarone Indene......
  Line of Piccoumaron resins provide
  skillfully balanced properties. Available in 10 melting points, from a
  liquid to a hard brittle solid. Request
  Bulletin and product samples.
  483E Pennsylvania Indus. Chem.
- Resins, Polyester Coating.....Outstand-ing performance in surface coatings is reported for XA polyester coating resins. Offers literature and product samples of this new development for the paint industry, 24-5e \*American Cyanamid Co.
- Resins, Polyethylene . . . . . Tough, flexible
  Alathon polyethylene resin stands up
  well against abrasive slurries. Widely
  used in industrial pipe applications.
  Offers complete information on the
  properties and applications.
  151e \*E. I. du Pont de Nemours.
- Resins, Polyethylene.....Petrothene resins are available in grades suitable for extrusion, compression, and injection molding, for use in the manufacture of films, bottles, pipe, etc. New "Petrothene" booklet.

  483F U. S. Industrial Chem. Co.
- ns, Tetrafluoroethylene.....Teflon tetrafluorotheylene resins used exten-sively in process industries. Offer chemical inertness, high heat resist-ance, low-temperature toughness, etc. Properties & applications. 151d \*E. I. du Pont de Nemours.
- ea, Fused . . . . Illustrated Folder describes Rotosil fused silica: applications (chemical, metallurgical, electrical); properties: physical charateristics; types of equipment available in Rotosil; etc.

  483G Amersil Co.

· See explanation on p. 478



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\*Du Pont's trade-mark for its tetrafluoroethylene resin

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#### LITERATURE . . .

- Soda Caustic....."Caustic Soda Buyer's
  Guide" contains helpful facts on economics of 50% & 73% solutions;
  other forms of caustic soda; capacities of tank cars & other containers;
  useful shipping data; etc.
  62
- Sodium Amide.....Sodium amide may provide the answer to your chemical processing problem. Makes available a detailed reference containing information on uses, preparation, properties and handling, etc.

  484A Ethyl Corp.
- Sodium Borohydride.....Features numerous uses; organic reductions; foaming agent; hydrogen generation; hydrogenation; etc. For technical information regarding sodium borohydride request Bulletin 582.

  484B Metal Hydrides.
- Sodium Phosphates..... Describes product line—sodium tripolyphosphate, tri-sodium phosphate (crystalline—monohydrate), tetrasodium pyrophosphate (anhydrous), sodium polyphosetc. Request new catalog & handbook.

  484C Blockson Chem. Co.
- Sodium m-Silicate.....Valuable data on Drymet anahydrous—the most highly concentrated form of sodium m-Silicate. Drymet File-Folder contains complete technical information and suggested formulations.

  BL415 •Cowles Chem. Co.
- Solvents.....Assure controlled evaporation. In paint & surface coating Industry . . solvents offer precise characteristics to meet your most exacting requirements. Full data on characteristics & specifications. 79 °Esso Standard Oil Co.
- Solvents.....Armid O acts as a mutual solvent for primary ingredients of quality wax paper coatings—1% of Armid O makes coatings transparent & flexible. Request product sample & a copy of the Armids Booklet.

  484D Armour Chem. Div.
- Solvents.....Versatile solvents feature important applications in the manufacture of inks and dyes, resins and plasticizers, textile chemicals, etc. Request complete information, Data Sheets, valuable product samples.

  484E Olin Mathieson Chem. Corp.
- Stabilizers.....Describes Stayrite #70
  —a new stablizer for polyvinylchloride
  type resins . . . combining superlor
  qualities of both cadmium & barium
  fatty acid soaps. Technical Service
  Bulletin No. S-2.
  484F Witco Chem. Co.
- Stearates.....Illustrated, 36 p. covers Witco stearates . . . their properties and uses. Includes alumium stearates, cadmium stearate, calcium stearates, lead stearates, lithium stearates, etc. Bulletin 53-1.

  4846 Witco Chem. Co.
- Styrene Monomer . . . . . Starting point for large volume chemical manufacturing —styrene-based dispersions, polyester resins, elastomers, styrene modified alkyd resins, styrenated oils, etc. Details in illustrated, 44 p.

  484H Monsanto Chem. Co.
- Styrene Monomer......Well-known throughout industry for its diversity of applications,.. this chemical may be the key to new or improved products in your field. Makes available samples and complete information.

  472 \*Koppers Co.
- Succinonitrile.....16 p. includes properties, summary chart of typical organic reactions, chemical reactions, potential uses, toxicity & handling information, & a bibliography. Technical Bulletin 0-116.

  4811 Monsanto Chem. Co.
- Suplphur Dioxide.....A versatile chemical reagent for industry, sulphur dioxide can be used as a reducing or bleaching agent, preservative, antichlor, neutralizer, pH control. Details in "Virginia SO2" Folder.

  166 Virginia Smelting Co.
- See explanation on p. 478

- Surface Active Agents.....Industry has found use for Aerosol surface active agents in thousands of processes and a progession of new uses. Numerous important applications highlighted in a new descriptive Booklet.

  24-5d \*American Cyanamid Co.
- Thixcin.....A fine white powder that swells in aliphatic solvents & most oil-based compositions to form a loosely knit lattice structure of tremendous supporting power. Offers sample & technical information, 485A Baker Castor Oil Co.
- Waxes, Cane.....The only domestic vegetable wax completely free of adulteration with other waxes. Positive laboratory-controlled uniformity. Company makes available complete information & product samples. 485B Warwick Wax Co.
- Zinc Dust.....Zinc dust as a reducing agent offers valuable advantages: original cost lower than most commonly used agents; works in alkaline & acidic solutions of varying pH; etc. Furnishes half-pint sample.

  485C Federated Metals Div.

#### Construction Materials

- Alloys, Fabricated . . . . Illustrated, 24 p. covers Rolock heat & corrosion resistant fabricated alloys. Contains photos of 74 baskets, trays, racks, retorts, fixtures, etc. Heat Treating Section Catalog No. B-8.
- Alloys, Hard-Facing..... Impart superior abrasion & corrosion resistance to finished metal parts. Spraywelder is a metal spraying unit for applying powdered Colmonoy alloys. Request new Model C Spraywelder Catalog. L416

  Wall Colomoy Corp.
- Aluminum.....Process industry applications of aluminum for producing everything from beer to bomb shells are thorougly analyzed in illustrated, 80 p. book, "Process Industries Applications of Alcoa Aluminum." 40-I \*Aluminum Co. of America.
- Castings.....Folder presents a variety of stainless steel cast parts with information as to alloy, weight & aplication. Also a complete data chart listing 28 alloys with recommendations for their use.

  338b \*Cooper Alloy Corp.
- Coatings, Protective....Arco experienced manpower—advanced methods —superior materials ... assembled to combat corrosion in every phase of industry. Examples of protection in fully illustrated, 4 p. Folder. 485E Automotive Rubber Co.
- Fabrication, Metal.....Booklet, "Facilities & Products," with information & photographs which show why company can turn out—at low cost—specialized heavy equipment for chemical plants, available upon request.

  35 \*Newport News Shipbuilding.
- Fabrication, Metal......Manufactures metal products for many industrial uses...from complete carbon-black plants to steel conveyor boxes. Designs, engineers and fabricates to specific needs. Full data.

  380

  \*Boardman Co.
- Fabrication, Plate.....Company is thorougly experienced in working and welding numerous alloys and clad materials, as well as the carbon steels and stainless steels. For complete details, request Bulletin PF.

  69 \*Downingtown Iron Wks.
- Fabrication, Process Equipment.....Designed and built around the use of Haveg—basic construction material that resists corrosion. Includes size and chemical resistance charts in 64 p. illustrated Bulletin F-6.

  364a \*Haveg Corp.

• See explanation on p. 478



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There are well over fifty.

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for new and improved applications.

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POLAR SOLVENT AND EXTRACTION—Furfural is useful in separating mixtures by solvent extraction or extractive distillation. Excellent selectivity, good phase separation, stability of the solvent, as well as ease and completeness of recovery are important features.

CHEMICAL REACTIONS OF THE ALDEHYDE GROUP—Furfural is an economical source of aldehyde for the preparation of phenolic resins. The furan ring exerts a modifying effect on the resultant resins and improves flow and deep draw properties, chemical resistance and wetting.

**REACTIONS OF THE RING**—Many cyclic and open chain compounds are readily and economically obtainable from furfural. Here is an example of one reaction route that has opened up an entire new field.

REACTIVE SOLVENT—Furfural is not only a powerful solvent but in some cases actually may be reacted with the solute, thus becoming a part of the final product. A good example of this is with phenolic resins. This property is valuable to manufacturers of abrasive wheels, brake linings and other products where wetting, solubility, and minimum production of volatiles are important.

A request on your letterhead for a sample and Bulletin 204 "Current Uses of Furfural" will receive prompt attention, and may be the start of a sound investment for you.



335Z The Merchandise Mart, Chicago 54, Illinois Roem 535Z,120 Wall St., New York 5, N. Y. Room 435Z,P. O. Box 4376, Portland 8, Oregon

In the United Kingdom: Imperial Chemical Industries, Ltd., Billingham, England In Eurepe: Quaker Oats-Graanproductan N. v., Rotterdam, The Netherlands; Quaker Oats (France) S. A., 3, Rue Pillet-Will, Paris IX, France In Australia: Swift & Company, Pty., Ltd., Sydney In Japans F. Kanemathu & Co., Ltd., Tokyo

#### LITERATURE . . .

- Fabrication, Process Equipment.....8 p.
  Bulletin outlines use of Type 1 polyvinyl chloride in fabrication of exhaust systems, process equipment &
  processing tanks. Includes section on
  plastic pipe & fittings.
  486A Atlas Mineral Products Co.
- Floors, Corrosion-Proof.....Illustrated reference describes Nukem corrosion-proof acid brick floors. Covers requisites of a corrosion-proof floor, specification, users, etc. A. I. A. File No. 3-B No. 3-F-11 (NN).

  486B Nukem Products Corp.
- Insulation, Block.... Eagle-Picher PV Supertemp block insulation . . . with the new "precision-finish." A highly efficient, all-purpose insulating block that is practically dustless. Offers product sample.

  55 \*Eagle-Pitcher Co.
- Insulation, Cellular Glass.....New Brochure tells how the use of Foamglas solved severe insulating problems of leading users. Shows application to insulate roofs, cellings, walls and floors, etc. Fully illustrated. 486C Pittsburgh Corning Corp.
- Insulation, Industrial.....No matter where your insulation job may be—
  Armstrong can give you efficient, well-integrated, on-the-job service from original spees to final installation.
  Descriptive Booklet.
  362 \*Armstrong Cork Co.
- Insulation, Pipe.....Amosite...the South African asbestos with long, strong, resilient fibers gives Unibestos pipe insulation greater strength and superior insulating ability. Data in Bulletin No. 109C. 160 \*Union Asbestos & Rubber Co.
- Rubber, Sponge.....Arco-Cel natural and synthetic closed-cell sponge rubber is unique in structure and versatile in application. Includes advantages, specifications, a chemical resistance table, etc., in illustrated, 4 p.

  486D Automotive Rubber Co.
- Steels, Stainless.....124 p. case-bound Handbook will help you to select right stainless steel & to use it properly. Furnishes comprehensive listings of analysis, properties & characteristics of each type. 358 \*Allegheny Ludium Steel Corp.
- Steels, Stainless...... "Stainless Steel & Textiles" presents story of stainless steels as they can be used in textile processing. Facts are backed by test data on average corrosion rate of different stainless types.

  486E Armco Steel Corp.
- Structural Materials . . . . Lamicor—a new structural material combing unique thermal, electrical, chemical & mechanical properties—fully described in illustrated Folder. Covers applications, specifications, etc.

  486F Strick Plastics Corp.
- Titanium......Shows resistance to chloride solutions and retains useful strength up to 800-1000F. Other advantages and data on application and fabrication of, titanium alloys in descriptive Rem-Cru Review.

  162 \*Rem-Cru Titanium.

#### Electrical & Mechanical

- Closures.....Sillers Flex Ring Closures offer advantages over conventional flange type of closures: low initial cost—less time for opening & closing (just one bolt)—ease of handling—etc. Bulletin No. 3000.

  \*\*Sillers Engrg. Co.
- Drives. Dry Fluid.....Flexidyne easily handles difficult starting problems, and gives a new kind of protection against shock and overloads. For complete product information, request company's special Bulletin.

  86-7
- \* See explanation on p. 478

- covers features of Type "S" & "SS" heavy duty diesel engines in sizes from 375 to 1000 hp. Data on lubrication, cooling & fuel injection systems of engines. Form 10,040.

  487A Ingersoll-Rand Co.
- Gaskets, Teflon.....The ideal seal for many process applications is a Flexi-tallic gasket with teflon trapped be-tween edges of stainless steel. For tween edges of stainless steel. For complete data request folder, "Teflon in Flexitallic Gaskets." 374 "Flexitallic Gasket Co.
- Motors.....Graphically illustrates improved types of U.S. vertical solid shaft motors. Includes Unimount vertical motors in ratings from \( \frac{1}{2} \) to 400 hp in grease & oil lubricated types. Request Bulletin No. 1868.

  487B U. S. Elecl. Motors.
- Motors.....Wagner Type DP motors are protected by rugged, corrosion-resistant cast iron frames, smoothly rounded so that no moisture can collect on them. For complete information, request Bulletin No. MU-202.

  152

  \*Wagner Elec. Corp.
- Motors, Explosion-Proof.....New literature shows complete line of explosion-proof motors, typical frame sizes designed and manufactured for the chemical industry. Describes in detail valuable construction features.

  487C Marathon Elec. Mfg. Corp.
- Motors, Fan Cooled.....Bearing, fully enclosed and protected, yet easy to grease when desired... gives more value for your motor dollar. Covers line of totally-enclosed fan-cooled motors in Bulletin No. 51B7225.

  34 \*\*Allis-Chalmers Mfg. Co.
- kings, Valve & Pump.....V-rings, cup and cone, and wedge type packings of chemical resistant pure teflon—engineered for greater flexibility and resiliency. Full information detailed in Bulletin TP-1053.

  379 \*C. S. Gasket Co.
- eys, Variable Speed.....Brochure covers Hi-Lo automatic variable speed pulleys & Hi-Lo systems. Lists advantages of pulley & is documented with graphs, dlagrams, cutaway views & photos of unit in action. 8 p. 487D Equipment Engrg. Co.
- Rims, Sprocket.....Operation of over-head valves solved thru use of Babbitt adjustable sprocket rim with chair nead valves solved thru use of Badditt adjustable sprocket rim with chain guide. Fits any valve wheel—quickly installed—low in cost. Folder shows many typical applications.

  487E Babbitt Steam Specialty Co.
- Seals.....For long dependable service where: economical operation is desired; operating conditions ar hazardous: loss of costly fluids must be prevented: complete sealing is required. Bulletin No. 455-CE.

  BL407
- Seals, Mechanical.....Combining chemically impervious teflon with a balanced bellows design—Chemiseal external mechanical seals last longer & give unsurpassed performance. Details in Bulletin No. MS-954.

  382 \*U. S. Gasket Co.
- Starters, Motor.....Built in wide range of ratings for squirrel-cage, wound-rotor & Synchronous motors...for full or reduced voltage...reversing or non-reversing. Details in Bulletin No. 14B6410B.

  369 Allis-Chalmers Mfg. Co.
- Switchgear.....Metal-clad switchgear rated 2.4 KV to 13.8 KV & 50 to 500 MVA fully described in illustrated, 52 p. Covers applications, installation, maintenance, design features, etc. Bulletin No. GEA-5664C. 487F General Elec. Co.
- Tefion Products......Illustrated booklet,
  "The Best in Tefion," covers data on
  tefion parts & products—bellows, bellows, bellows connectors, pump & valve packings, tubing & other molded forms.
  12 p. Chemlon Catalog.

  391a \*Crane Packing Co.
- See explanation on p. 478



Flat Wire Mesh



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Twilled Weave



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Oblong Mesh



Plain Dutch Filter



Twilled Dutch Filter





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#### Handling & Packaging

Baggers, Gross.....Describes and illustrates company's manually-operated gross bagger. Lists features and includes a dimensioned engineering drawing showing top and side views. Request Data Sheet No. 5301.

488A Richardson Scale Co.

Buckets, Elevator.....Designed for handling maximum capacties of granular, free-flowing materials at high speeds. Includes construction features, design recommendations for high-speed elevators, etc. in Folder 2548.

488B Link-Belt Co.

Conveyor-Elevator Systems.....For bulk handling problems where corrosion, degradation, dust or economical adaptation to limited space or plant layout are vital considerations. Information in Bulletin No. 349. 172 \*Stephens-Adamson Mfg. Co.

Conveyors, Natural-Frequency..... Work on unique, patented vibrating principle which permits them to handle many materials too tough for most screw, belt, apron, vibrating, etc. conveyors. Data in Bulletin 111.

Conveyors, Screw.....Feature efficient operation plus long-life, low maintenance service. Company makes avaliable a 92 p. screw conveyor book of pre-engineered selection and application data. Book No. 2289.

13 \*Link-Belt Co.

Conveyors, Vibrating.....G-W Oscilveyor offers most inexpensive, practical way to move loose bulk materials—at speeds up to 50 ft per min. New Idea Book on engineered materials handling plus full Oscilveyor story.

TL491 \*Gifford-Wood Co.

Drums.....Tight head or removable head types . . . protect sensitive chemicals, oils, and food products agains contamination during shipment or in storage. Data in Hackney Drum and Barrel Catalog. 363 \*Pressed Steel Tank Co.

Feeders.....Available in 8, 10 & 12-inch sizes, Prater Airlock feeder saves money in handling practically any finely ground or granulated material including most highly abrasive substances. Illustrated Brochure.

473 \*Prater Pulverizer Co.

Feeders.....From 100 lbs./hr. to 100 tons/hr. are suspended from the feed bin which: eliminates costly feeder support structure; provides accessibility to equipment following feeder. Data in Bulletin 33-E-11.

410a \*Hardinge Co.

Feeders—Conveyors—Stackers.....Entire installations built to withstand adverse conditions . . to operate efficiently at low cost . . to meet rigid engineering standards. Information in Catalog 852.

365

Feeders, Weighing..... Never before has a weighing feeder attained the accuracy of the Omega Hi-Weigh.—the new feeder with the revolutionary Sens-A-Gram Controller. Complete details in Bulletin No. 37-M1. 167 Omega Mach. Co.

Feeders, Wet Reagent.....Accurately meter minute quantities of liquid from 0 cc to 2000 cc per minute. Float valve in tank permits connection of feeder to bulk storage device. Data in Bulletin F6-B8.

475e \*Denver Equipment Co.

\* See explanation on p. 478

- Magnets, Grate..... Designed for removing tramp iron and fines from free-flowing dry materials such as grains, coffee, dried fruits and foods, to-bacco, pelleted products, etc. Complete data in Bulletin B-214.

  417b \*\*Eriez Mfg. Co.
- Scales, Crane.....SR-4 is a convenient & rugged device for weighing objects at same time they are being lifted by a crane. Covers features, instrumentation, installation, etc., in illustrated 12 p. Bulletin 4304.

  489A. Baldwin-Lima-Hamilton Corp.
- Traps, Pipeline.....Designed for efficient removal of unwanted from and fines from almost all types of liquids flowing thru pipelines, Ferro-traps protect costly screens, pumps, mixers, etc. Bulletin B-605. 417e \*Eriez Mfg. Co.

#### **Heating & Cooling**

- Boilers.....Numerous valuable features make self-contained boilers first choice for commercial, institutional and industrial applications. In sizes 15 to 500 hp, 15 to 250 psi. Details in Catalog No. AD-100.

  349 \*Cleaver-Brooks Co.
- Burners.....Thousands of burners, in chemical industries, have speeded up and improved many heating processes. 80 types and 800 sizes completely described and rated in detailed Catalog. Literature H54-16. R407 \*Surface Combustion Corp.
- Chillers, Liquid.....The flexibility of the Acme Flow-Therm liquid chiller for air conditioning, heat pump & industrial liquid cooling applications is explained in new reference. Request Catalog No. 220-A.

  489B

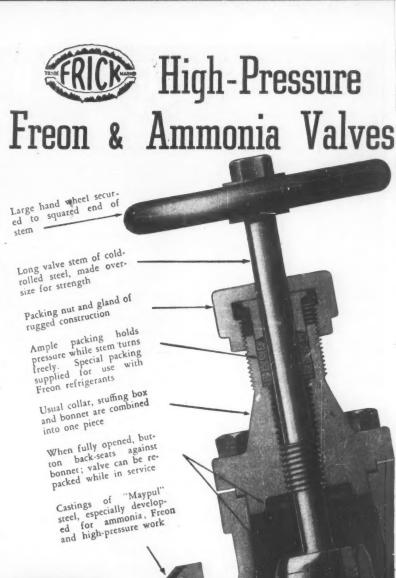
  Acme Industries.
- Coolers, Air-Quenching.....Information on how savings can be effected in the cement, lime and chemical industries through use of an air-quenching shaking grate cooler. Details in illustrated Bulletin No. 07B7869. 311 \*Allis-Chalmers Mfg. Co.
- Coolers, Cascade.....Designed for cooling corrosive liquids and gases. Low initial cost and maintenance, radiused returns for low pressure drop as well as redwood waterguide strips. Request Catalog No. S-6820.

  281e \*National Carbon Co.
- Generators, Steam.....Available in bent tube types and straight tube, forged steel sectional header types for solid, liquid, or gaseous fuel burned singly or in combination. Bulletins cover complete line. 174 \*Henry Vogt Mach. Co.
- Generators, Steam.....Compact, completely factory assembled & Factory Fire Tested "Keystones" fit into any plant's variable steam needs. Covers fully automatically controlled Keystone in Bulletin No. SB-51.

  43 \*Erie City Iron Wks.
- Heat Exchanger Sections.....Available
  with mild steel, stainless, alloy and
  non-ferrous fintubes... in standard
  sizes... for a wide range of capacities and pressures. Information in
  Bulletin No. 512.
  78a \*Brown Fintube Co.
- Heat Exchangers....Describes how equipment offers: chemical resistance to practically all corrosive fluids; resistance to servere thermal shock; high heat-transfer rates; low maintenance; etc. Catalog S-6740.

  281e \*National Carbon Co.

• See explanation on p. 478

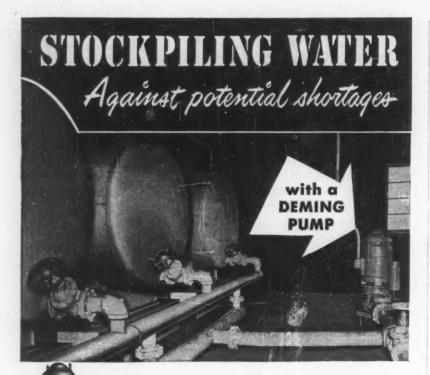




Catalog O Gives Sixes, Symbol Numbers, Dimensions and Weights of Valves, Fittings and Accessories. Get Your Copy Naw

Flanges of standard sizes, to other fittings. also available in zes up as valve enters





 A réserve supply of water for protection against shortage is a "preventive form of insurance." That and other considerations caused a midwestern manufacturer to call in a Deming Distributor for assistance in planning the company "water works" illustrated above.

Other considerations included the high cost of "city water;" the uncertainty of city supply during summer peak demands; and the need to process water in advance of its use in plant operations.

Water is pumped from a 140-ft. deep well on company property. Capacity of the Deming Vertical Turbine Pump is more than 650,000 gallons a day at 50-70 lbs. pressure. Pump is operated by a 50 H.P. motor. The three storage tanks shown in the picture have a combined capacity of 22,500 gallons.

The "pay-off" on this installation is the big reduction in water costs and the "preventive insurance" against possible stoppage of plant operations due to lack of water.

Investigate the advantages of Deming Vertical Turbine Pumps. Write for BULLETIN NO. 4700.

THE DEMING COMPANY 525 BROADWAY . SALEM, OHIO



#### LITERATURE . . .

- Heat Exchangers....Illustrated, 16 p. includes sections on: company's history; engineering department; fabrication facilities; economics of design of heat exchangers; quality control, testing, research.

  490A Western Supply Co.
- Heat Exchangers.....Presents a fully illustrated 12 p. reference describing company's line of Impervite impervious graphite equipment . . for high efficiency chemical heat transfer. Request Catalog HE 642.

  490B Falls Industries.
- Heat Exchangers....."WU" heat exchanger is an extremely versatile, instantaneous water heating unit, with a wide range of applications. Covers features, materials of construction, ratings, etc. Bulletin GC-1054.

  499C Bell & Gossett Co.
- Heat Exchangers, Tube Bundle.....New standardized heat exchanger design features lower first cost, more area per unit, choice of tube lengths, faster delivery, etc. Company offers full de-tails in Catalog S-6840. 281d "National Carbon Co.
- Heating Systems, Dowtherm....Furnishes descriptive information on Dowtherm heating systems for processes requiring precision control of high constant temperatures at low pressures, in Bulletin ID-54-5.

  127 \*Foster Wheeler Corp.
- Humidity Conditioning.....Stops mois-ture regain in ammonium nitrate using 87°F coolant to get 46°F dew-point. Economical, rugged & safe Kathabar units are fully described in Literature Group No. K54-3. 366 \*Surface Combination Corp.
- Platecolls..... Designed for tank heating and cooling problems due to inefficient pipe coils. These cost-saving plate-colls heat or cool 50% faster and take 50% less space in the tank. Of-fers Bulletin No. P61. \*Tranter Mfg.
- Towers, Cooling.....Describes LoLine cooling towers . . . specifically designed for air conditioning applications—with the lowest silhouette of any tower of 75 ton capacity or larger. Bulletin No. 5.1.902.

  490D J. F. Pritchard & Co.
- Towers, Cooling.... Reflect over 50 years of experience in meeting specific needs of all types of power & process plants. Engineered & constructed to give maximum performance at minimum cost. Catalog No. CT-52-4. mum cost. Catalog No. CT-52-4. 402 \*Foster Wheeler Corp.
- Traps, Steam.....Lists numerous features of Thermodynamic steam traps such as: only one moving part; practically no maintenance; no changing of heads or seats; close tight on no load; etc. Illustrated Bulletin 255-A.

  490E Sarco Co.
- Traps, Steam.....Company makes available a descriptive 44 p. Steam Trap Book which furnishes complete trap data and prices plus useful selection, installation and maintenance information. Request Catalog '17."

  350 \*Armstrong Mach. Wks.
- \* See explanation on p. 478

-> Want more information on any of these items? Just circle its code number on the postcard inside the back cover, then mail to us. It's that easy now.



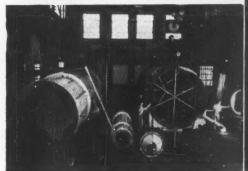
Three drive weights - for better distribution, smoother running. All vibration put to work by heavy duty reciprocating springs and new-design rubber-cushioned rocker arms. If a vibrating-type conveyor fits into your picture don't buy without seeing G-W Oscilveyor first! Write today.

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#### FABRICATING FACILITIES

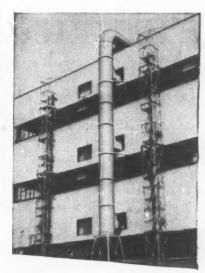
Davenport Machine & Foundry Company has adequate facilities for fabricating drying equipment from the smallest laboratory units to the largest commercial units.

Three units in the process of fabrication in our plant are pictured above. The unit to the left — ROTARY DIRECT FIRE DRYER — 7'-0" dia. x 50'-0" long. The unit in the center - ROTARY HOT AIR DRYER (stainless steel) 2'-3" dia. x 14'-0" long.

The unit to the right - ROTARY AIR COOLER - 10'-0" dia. x 50'-0" long.

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## IS A PLA-TANK® STACK THE ANSWER TO YOUR **FUME PROBLEM?**

Shown here is a light-weight, easily-erected PLA-TANK stack which handles fume exhaust at the new thorium plant of the Lindsay Chemical Co., West Chicago, Ill. The stack has a 44" diameter, is 69' long including 90° elbow, cross run to fan chamber and riser beyond fan. There are inlets from three floors to handle exhausts from individual tank systems. Stack was prefabricated with systems. Stack was prefabricated with flanges for fast installation.

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MERCO CENTRIFUGAL CO.

#### LITERATURE . . .

Tubes, Condenser.....Resisting different types of corrosion, they eliminate need for frequent retubing & shutdowns— improve heat-transfer characteristics— reduce maintenance costs. Tech-nical Bulletin No. 1954. 85 Bridgeport Brass Co.

#### Instruments & Controls

Amplifiers, DC.....A key instrument in new PowrAmp line of electro-pneu-matic & electro-hydraulic measure-ment & control components with un-usual sensitivity & accuracy. Full story in Bulletin MSP-111.1. 68

Amplifiers, Magnetic.....Technical aspects of Magamp magnetic amplifiers for control applications covered in 20 p. booklet. Includes basic theory underlying magnetic amplifier operation. Technical Data 52-600.

492A Westinghouse Elec. Corp.

Analysis of Light Hydrocarbons.....The Fracton is the product of a new ap-proach in the development of a faster and simpler method of analysis of light hydrocarbon gases. Complete in-formation in Booklet No. 82. 492B Burrell Corp.

Analyzers.....Tri-Non & Bichromator analyzers continuously record concen-tration of any desired stream com-ponent. Each is sensitized & adjusted to specific plant conditions before shipping. Full details. 299 \*Perkin-Elmer Corp.

Analyzers, Infrared.....Complete details on infrared analyzer (Type 38-101). Handles up to five streams at a rate of five analyses per hour per stream, i.e., 12-minute cycle period, Request Bulletin CEC 1840-XI. 309a \*Consolidated Engrg. Corp.

trol, Coordinated . . . . . Coordinated control helps reduce cost of high pressure animonia plant. Fully illustrated Composite Catalog No. 5002 provides a condensed description of complete Honeywell product line.

324-5 \*Minneapolis-Honeywell Control.

Centrol Systems, Reactor.....Package reactor control in its various aspects is completely described in company's new illustrated Brochure. Request your copy of "L&N Control Systems for Nuclear Reactors."

90 \*Leeds & Northrup Co.

Centrollers:....Taylor Fulscope controllers provide valuable features: unit construction — easy low-cost maintenance—simple adjustments—versatility — simple operation — etc. Details in Bulletin No. 98151.

44-5 Taylor Instrument Cos.

Controls, Temperature.... Designed to control and indicate temperatures of gases, liquids or hot plates over wide ranges. Typical applications, outstanding features, engineering data, etc., in Bulletin No. 42.

492C United Elec. Controls Co.

Instruments, Electronic Process Control
.....Illustrated, 32 p. includes sections on: electronic communication in
process control; major elements & design features; miniature recorder; etc.
Bulletin 164.
156-7 \*Manning, Maxwell & Moore.

Potentiometers....Makes the most complete line of precision potentiometers...linear and non-linear versions...
in the widest choice of sizes, mounting styles, resistances. Information in Data File 000.

492D Helipot Corp.

Recorders.....Offer valuable features: pre-calibrated plug-in receiver units; up to 4 pneumatic or electronic re-ceivers—or 2 receivers & 2 integra-tors; etc. Product specification No. E12-5 available upon request. 342 \*Bailey Meter Co.

June 1955—CHEMICAL ENGINEERING

See explanation on p. 478

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vacuum feeding, instead of pressure, to pack powder into a container.

Air is removed from the container to create a vacuum which draws a measured quantity of powder from the hopper. There is no problem with dust control, since the unique Vacuflow method simply does not involve air currents that cause dust.



Rotary Model

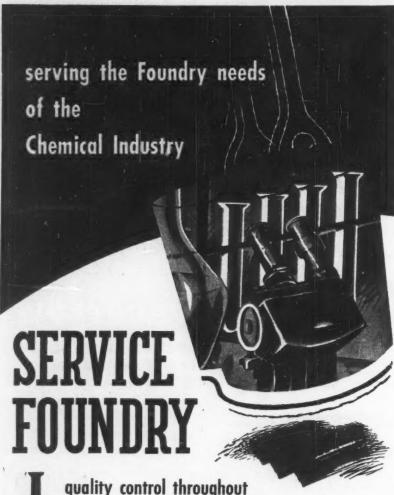
Semi-automatic models are available for filling containers ranging from the tiny talcum box up to and including 100 lb. paper bags and 200 lb. drums. Rotary models are available for automatic production of 5 lb. sizes or less at speed of 45 to 300 per minute.

Pneumatic is the one manufacturer in a position to furnish machines for making up complete production lines. Units are available for air cleaning.

Model E incs. Units are available for air cleaning, powder and liquid filling, capping and labeling a wide range of bottles, cans or jars.

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#### LITERATURE . . .

- Refractometers, Process....Describes process refractometers (Type 38-201)...for monitoring or control of fractionating towers and streamblending operations. Request valuable Bulletin No. CEC 1839-X1.

  309b \*Consolidated Engrg. Corp.
- Regulators, Temperature.....With dependable Sylphon regulator ... you can make quick changes in temperatures for liquids, air or gases. Sturdily built for years of trouble-free service. Request Catalog LC-D.

  392 \*Fulton Sylphon Div.
- Rotameters.....20 p. book includes; side plate construction & safety features; flow capacity charts; details of design & construction; dimension drawings; tube & float material & design data; etc. Bulletin 115.

  494A Brooks Rotameter Co.
- Spectrophotometers......Versatile and accurate, the G-E spectrophotometer has a range of 380 to 700 millimicrons. Instrument will measure both transparent and opaque samplings. Data in Bulletin No. GEC-307.

  353 "General Elec. Co.
- Spectrophotometers, Infrared . . . . Newlyrevised 12 p. brochure covers the Beckman IR-2 infrared spectrophotometer & accessories. Includes comments on infrared analysis & instrument design. Bulletin 153-E. 494B Beckman Instruments.
- Telemetering Systems.....Describes the Varec Pulse Code telemetering system , . . for reliable liquid level readings over distances limited only by the availability of communications facilities. Bulletin CP-3008.

  494C Vapor Recovery Systems Co.
- Telescopes, Industrial.....A. C. M. I.
  Borescopes permit close-up visual examination of interior areas & surfaces
  not otherwise visible. They save time
  & money & prevent costly dismantling. Request Folder.
  TL403 \*American Cystoscope Makers.
- Thermometers.....Sturdy all-metal construction resists breakage, makes for far longer life on operating equipment. Exclusive multiple helix assures dependable accuracy during long life. Descriptive Bulletin.

  424 "Weston Elecl. Instrument.
- Transmitters, d/p Cell.....Pioneered by Foxboro seven years ago . . the d/p Cell Transmitter established a new standard of performance in flow measurement and control. Describes design features in Bulletin 13-11, 50-1 \*Foxboro Co.
- Transmitters, Pneumatic.....36 p. reference covers transmitters for measuring flow, pressure, level or density, Describes & illustrates 22 different models, gives hook-ups, ranges, performance data. Data Book 1004, 42 \*Republic Flow Meters Co.

#### Pipe, Fitting, Valves

- Elbows, Long Tangent..... Feature many advantages: save pipe: often eliminate short nipples and their extra welds: save time and money in lining up and clamping pipe and fitting; etc. Catalog No. 54.

  \*Midwest Piping Co.
- Fittings.....Offers Klinger Master Catalog describing the complete range of products . . compressed asbestos sheet packings for all purposes, valves, cocks, level gages, synthetic and silicone rubbers, etc.

  297a \*Klinger Corp. of Amelca.
- Fittings, Flare..... Triple-lok fittings are easiest, fastest & safest way to tube up even in close quarters. Leakproof even under severe conditions of vibration, high pressures & temperatures. Catalog No. 4300,

  31a \*Parker Appliance Co.

<sup>\*</sup> See explanation on p. 478

- Fittings, Forged Steel.....Wherever strong, tough pipe joints are needed .... Watson Stillman forged steel fittings provide a safety factor against costly piping failures. Details in Bulletin No. A3-50.

  399a \*Watson-Stillman Fittings.
- Fittings & Hose Assembles....New Hoze-lok fittings and hose assemblies (for medium and high pressure hydraulic service) offer better performance, easier make-up, greater re-usability. Catalog No. 4400.

  31b \*Parker Appliance Co.
- Fittings, Pipe..... Presents newest catalogue of stainless steel pipe fittings which shows all standard pipe fittings and flanges, flanged fittings, butt weld fittings, etc. Request fully illustrated Catalog No. 653.

  54a

  \*Camco Products.
- Fittings, Stainless Steel.....New stainless steel fittings will assure you of long, trouble-free service in tough piping applications . . . will reduce down-time and cut maintenance costs. Bulletin No. S-3-55.

  399b \*Watson-Stillman Fittings
- Fittings, Tube.... Announces Parker
  Weld-lok tube fittings... machined
  from high-quality steel or stainless
  steel bar stock and forgings... for
  tubing \( \frac{1}{2} \) thrue 2 in. O.D. Information
  in new Catalog No. 4370.

  31c \*Parker Appliance Co.
- Fittings, Tube.....New Intru-lok tube fittings can be quickly installed by anyone. Simply push tube in, then tighten nut. Designed for instrumentation lines of ½ thru ½ inch, O.D. Request Catalog No. 4320A1.

  31d \*Parker Appliance Co.
- Flange Specifications.....Company announces the development of a new Flange. Specification table for ASA and MMS Flanges in a convenient, slide rule form. Pocket-size reference is available upon request.

  54b \*Camco Products Co.
- Hose, Metal, Flexible.....Ideal for difficult fluid and gas handling jobs. Durable and leak-proof for conveying, controlling movement and vibration, correcting misalignments, etc. Full details in Bulletin No. 20D. 18 \*Atlantic Metal Hose Co.
- Pipe & Fittings For corrosionresistant piping. Impervious graphite pipe & fittings readily installed, long lasting, easily maintained, unaffected by most corrosive fluids. Request Catalog No. S-7000. 281b National Carbon Co.
- Pipe & Fittings, Polyvinyl Chloride.....

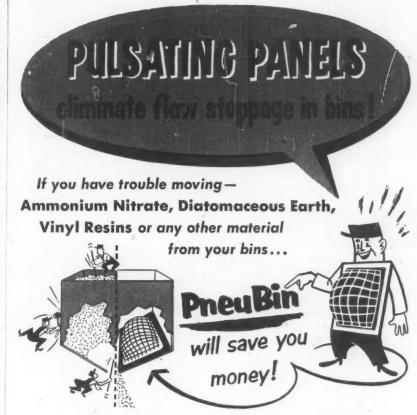
  Furnishes information on ½" to 4" line of normal impact & high impact unplasticized polyvinyl chloride pipe & fittings, plus properties & characteristics data, etc.

  TL407 \*Alpha Plastics.
- Pipe, Plastic.....Ace hard rubber—now more than a century old—long the finest corrosion-resistant pipe available. Widest variety of fittings of any rigid non-metallic pipe. Details in Bulletin No. CE-51. 397a \*American Hard Rubber Co.
- Pipe, Plastic ... General-purpose moderately priced rubber-plastic pipe handles most common chemicals to 170°F . . except few strong acids & organic solvents. Tough, odorless, tasteless. Bulletin No. 80.

  396a \*American Hard Rubber Co.
- Tubing & Pipe, Stainless Steel.....Resistance of 7Mo to stress corrosion cracking, even in presence of chlorides, is coupled with excellent resistance to general corrosion and pitting. Technical Bulletin. 427 \*Carpenter Steel Co.
- Unions, Forged Steel..... Describes line of new forged steel unions. Presents complete dimensions of unions in sizes in to 2" in 3000 lb. class. Also covers outstanding design features. Illustrated Bulletin U-1.

  399e \*Watson-Stillman Fittings.

\*See explanation on p. 478



PreuBin will solve your flow stoppage problems and reduce your operating expense. The PneuBin unit consists of steel-backed, neoprene, pulsating panels mounted on the inside wall of your present bins and air controls to regulate the panels' action. By the pneumatic inflation and deflation of the Pneu-Bin panels, the bin contents are positively displaced to insure free flow. After the panels have deflated, the air control unit (operating off the regular plant air supply) starts another cycle of inflation and deflation. The process continues *automatically* at whatever frequency is set on the air controller (this frequency is adjustable).

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BUTTERFLY VALVES

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Three 20" R-S Butterfly Valves are used in hot-gas lines handling highly corrosive gas year 'round.

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R-S Butterfly Valves were chosen to meet the varied demands of a sulfuric acid plant producing 600 tons per day on a year-round schedule. On the hot side of the process, 20" R-S Butterfly Valves are used for fast, dependable volume and temperature control. They are on the hotgas lines at the heat exchangers where temperatures are a constant 1150 F.

On the cold side, 30" R-S Butterfly Valves meter cold air at 30,000 cfm to the sulfur gas furnaces. Two 20" valves are used in by-pass airlines, safeguarding the proper air-sulfur mixture. They were chosen for their ability to move fast – fast enough to ensure close control of an unstable compound which becomes useless if too much hydrogen or oxygen is added.

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Free-Discharge Valves Controllable-Pitch Ship Propellers

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#### LITERATURE . . .

- Valves.....Covers design, operation & advantages of A-S-H Type C materials handling valves. Employs photos, schematics & line drawings to illustrate valve construction & operation. Data Sheet DVa.

  496A Allen-Sherman-Hoff Co.
- Valves.....Versatile, dependable, economically-priced hand valve...for corrosion, abrasion, vacuum or general service—wherever positive action is needed. Details of X-V Series in Bulletin No. FL-154. 14-5a \*Farris Flexible Valve Corp.
- Valves.....Ultravalve design solves many of the new application problems presented by modern process control. Covers structural features, functional advantages, specifications, etc. in illustrated Bulletin 103-B. 496B. – Hammel-Dahl Co.

18

- Valves, Bronze.....Covers OIC 500 line—modern 200 lb. bronze valves. Includes features, service recommendations, working pressures, etc. for globe & angle valves—horizontal & angle checks. Form No. 1001.

  496C Ohio Injector Co.
- Valves, Check.....Low head loss, increased wear resistance and freedom from destructive slamming make line of tilting disc check valves unbeatable for almost every installation. Details in Catalog No. 30. 361 \*\*Chapman Valve Mfg. Co.
- Valves, Diaphragm......Trouble-free plastic diaphragm valves—choice of general-purpose Ace-Ite, Ace Parian (polyethylene) or Ace Saran. Handles most corrosive chemicals & food ingredients Bulletin 351. 396b \*American Hard Rubber Co.
- Valves, Diaphragm Control.....Throughout the entire range of valve travel positioning is accurate & undistorted control increments are finer with minimized positioning error. Full details in Bulletin CV-53. 303 \*Kieley & Mueller.
- Valves, Diaphragm, Packless.....Eliminate stem leakage and maintenance on air, vacuum, gas, light oil and similar services. Available in wide selection of materials and sizes. Request Folder No. AD-1942.
- Valves, Engine-Stop...... Prevent flywheel explosion . . . with G-A automatic engine-stop valves. Automatically close when turbines, compressors or engines overspeed. Request detailed Bulletin S-3. \*Golden-Anderson Valve.
- Valves, Globe & Check..... Design & construction of valves dictated solely by requirements for the handling of chemicals. Ruggedness, quality & low maintenance costs featured. Illustrated Bulletins Nos. H-1 & H-2. 307

  \*La Bour Co.
- Valves, Pinch-Type.....No other valve controls flow of hard-to-handle corrosive & abrasive materials with efficiency & reliability of pinch-type valve . because Flex-Valve cannot plus. Catalog No. FL-382.

  14-5b \*Farris Flexible Valve Corp.
- Valves, Plug......Company's line of nonlubricated steel plug valves features dependable performance at a wide range of temperatures and pressures. For complete details, request informative Wedgeplug Catalog 54-1-W. \$47
- Valves, Porcelain.....Company makes available detailed literature covering the features and advantages of porcelain valves. Bulletin includes complete description, characteristics and specifications.

  345

  \*Lapp Insulator Co.
- Valves, Safety Belief.....Liberally illustrated, 132 p. describes line of safety relief valves ... standard valves & balanced beliows valves ... for process industries & general industry service. Catalog 1900.

  496D Manning, Maxwell & Moore.
- See explanation on p. 478

- Valves, Solenoid.....Packless—pistonpilot operated—globe bodies—union bonnet—certified alloy castings screwed or socket weld ends—full ports to 1000 psi. Complete details on product line in Bulletin K. TL413 \*J. D. Gould Co.
- Valves, Stainless Steel.....Feature large handwheel—extra heavy seats, stems, discs—100% x-ray of vital cast components—centerless ground stem deep stuffing box—etc. 1955 Valve & Fitting Catalog. \*Cooper Alloy Corp.

## **Process Equipment**

- Absorbers.....For absorption of hydrogen chloride and other gases. Produce as much as 20 tons per day 22° Baume acid. Pneumatic automatic control. Complete information offered in Catalog No. S-7460. 281f \*National Carbon Co.
- Centrifuges.....For toughest concentrating & separating jobs. Sharples DH-3 is built for those many applications requiring higher than normal throughput capacity & heavy duty performance. Request Bulletin 1279. 123 \*Sharples Corp.
- Crushers, Double Roll..... \*\*cLanahan
  Black Diamond double tool crusher
  for low-cost crushing of chemicals
  ... lime ... cinders ... and other
  similar materials. Full details in Bulletin No. BDDR-255.
  398 \*McLanahan Stone Corp.
- Crushes, Jaw.....Cast steel frame, manganese jaw & cheek plates. Large diameter shafts reduce shaft deflection & thus increase life of heavyduty, oversize roller bearings in bumper. Bulletin No. C12-B12.

  475d \*Denver Equipment Co.
- Dryers.....Lectro-dryers can dry air & gases in volume to dewpoints below 100°F—can drop relative humidity lower than 10%. Booklet describes machines & how various industries use them to gain efficiency.

  82 \*Pittsburgh Lectrodryer Corp.
- Dryers.....Available in several types: direct heat, indirect heat, and steam tube. Let Deco engineers help solve your drying problem—no dryer problem too small or too large. Details in Bulletin No. D4-B2. 475j Denver Equipment Co.
- Dryers, Rotary.....Makes available an illustrated Catalog with valuable information on company's line of dewatering presses & screens, rotary steam tube, hot air & direct fire dryers, water tube & air coolers.

  BL491a \*Davenport Mach. & Foundry
- announces the availability of literature on their vacuum drying equipment (Catalog No. 720) and a new reference covering Stokes Laboratory facilities (Bulletin No. 640).

  419
- heat transfer, plus rapid vapor removal . . means today's best in vacuum drying with the Patterson Conaform. For complete product information, request new Bulletin, 135 \*Patterson Foundry & Mach.
- Drying Equipment, Spray.....16 p. includes facts, photographs, and diagrams explaining the principles and advantages of spray drying and the Swenson plant-scale research laboratory. Request Bulletin D-105.

  6-7a \*Swenson Evaporator Co.
- \*\* See explanation on p. 478

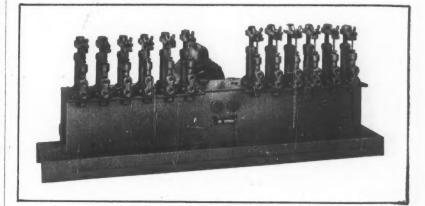
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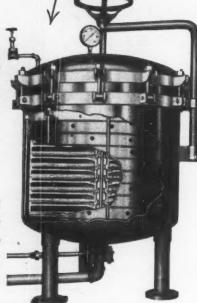
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... for all fine filtering

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batch, and allows practically a complete recovery of the product.

Constant filtering quality is maintained from start to the end
of the cycle, no break through can occur in a Sparkler Horizontal
Plate filter.

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#### LITERATURE . . .

- Dust Collectors....Model D Aeroturn combines high-efficiency filtering with reverse-air-jet filter cleaning. Saves valuable space...eliminates erection costs. For full information, request Bulletin No. 3027. BR411 \*Turner & Haws Engrg. Co.
- Dust Collectors.....In almost every type of industry... users have found high efficiency, simplicity & economy of Dustube collectors a difficult combination to equal for top performance. Details in Bulletin 372.

  66 \*American Wheelabrator.
- Dust Collectors.....Series 12 Aeroturn line provides 99.9%+ air-cleaning efficiency. Completely illustrated, 16 p. includes sections on: how it works; construction & assembly; features; installations; etc.

  498A Turner & Haws Engrg. Co.
- Dust Control.....Pangborn engineers help solve your dust problems—line of wet or dry dust collectors can save time, trouble & money. See how varied industries are benefited in "Out of the Realm of Dust."

  \*Pangborn Corp.
- Dust Recovery.....New profits in terms of valuable dust that can be returned to production rather than wasted in the air. Presents an informative Brochure which describes three systems of industrial dust recovery.

  38 \*Buell Engrg. Co.
- Filters.....Describes full line of industrial Auto-Klean filters. Includes data on principle, construction, operation, advantages, specifications, capacities, applications, case studies, etc. Catalog AK050.

  498B Cuno Engrg. Corp.
- Filters, Pressure Leaf.....For flow rates two to five times greater than cloth covered presses; positive removal of all suspended solids to desired degree of clarity; etc. Find complete details in Catalog No. NC-1-53, 259

  \*Niagara Filters Div.
- Filters, Vacuum . . . . . Vacuum filters made in 3 ceramic bodies: white chemical porcelain; standard Denstone chemical stoneware; Ceratherm-550 heatshok-resistant chemical stoneware. Bulletin F-40.
- Generators, Inert Gas.....Ald in solution of purging or blanketing problems. Complete with the latest fire checks and safety devices. For essential details and technical information request Bulletin 1-10.

  39 °C. M. Kemp Mfg. Co.
- Impactors.....Offer lowest possible costper-ton in producing top quality materials from 2" down to 35 mesh with a minimum of fines—or much smaller where more friable products are handled. Detailed literature. 287a \*Williams Patent Crusher.
- Kilns, Rotary.....Efficient thermo<sup>2</sup>processing of products. Used in the production of lime, bauxite, cement, sodium silicate, alumina, etc. Complete data on design features offered in illustrated Bulletin 1115.

  150a \*Traylor Engrg. & Mfg. Co.
- Lubrication Systems.....Trabon lubrication systems guarantee that the right amount of oil or grease will be delivered to vital bearings... at the right time and in the right place. Details in Bulletin No. 529. 131 \*Trabon Engrg. Corp.
- Mills, Ball & Pebble.....Outstanding in the field of fine grinding, mixing and processing. Built of all steel welded construction, they feature great strength and ruggedness. 20 p. illustrated Catalogue No. 100. 158a \*International Engrg.
- Mixers.....Abbè Dispersall mixers give you power & speed, plus tremendous advantage of easy cleaning, which readily allows shifting from one color or formulation to another. Complete details in Catalog 68. 414 \*Abbè Engrg. Corp.
- \* See explanation on p. 478

- Mixers.....Company makes available Confidential Mixing Data Sheet. Helpful checklist enables you to develop a complete technical description of agitation required for your process, quickly & easily. No. B-107. 257a \*Mixing Equipment Co.
- Mixers. Describes Super Agitators & Mixers. Patented standpipe around propeller shaft assures positive agitation & circulation. Patented wearing plate prevents sand-up on shut-down. Bulletin No. A2-B4.

  475a \*Denver Equipment Co.
- Mixers.....Announces 24 p. fully illustrated "International Mixer Pictorial" which covers company's line of portable mixers, propeller mixers, mixer drive heads, side entrance mixers, etc. Catalogue No. 79.

  158b \*International Engrg.
- Mixers.....Data on turbine & slow speed heavy duty agitators . . . for open & closed tanks. Covers operation & applications of super-turbine & injection mixers, mixer data, mixer drive heads, etc. Bulletin No. 76. 158c \*International Engrg.
- Mixers.....Mix-Mullers for chemical and process industries. Covers Simpson mulling principle; mulling for dry, wetted and plastic mixtures; Mix-Mullers for special requirements; etc. 12 p. Bulletin No. 522. 289 \*National Engrg. Co.
- Mixers, Dry..... Describes conical blenders (design, operation, application, capacity, sizes & specifications) & ribbon mixers (operating & construction features, specifications, etc.) Illustrated Bulletin No. 78.

  158d \*International Engrg.
- Mixers, Portable..... Use in industry reduces costs, saves time, labor and secures better and more refined products. Catalog includes data on construction, dimensions, specifications, etc. 28 p. No. B-108.

  \*Mixing Equipment Co.
- Mixers. Portable.....Includes information on the numerous features and advantages, materials of construction, sizes and specifications, portablepermanent mountings, etc., in illustrated Bulletin 74-A.

  158e \*International Engrg.
- Mixers. Side Entering.....The Type
  "NU" side entrance mixer is a brand
  new unique mixer design. It has no
  cast parts and is of all welded construction, including the stuffing box.
  Illustrated Bulletin No. 72-A.
  158f \*International Engrg.
- Mixers, Side Entering.....Furnishes detailed information on features, typical applications, mechanical design, maintenance, shaft seals, methods of installation, etc. in completely illustrated Catalog B-104. 257e \*Mixing Equipment Co.
- Mixers, Top Entering.....Makes available pertinent information on topentering mixers (propeller type)...
  for closed tanks, pressure & vacuum... for onen & loose-covered tanks. Data in Catalog B-103.

  \*Mixing Equipment Co.
- Mixers, Top Entering.....Illustrated and detailed 32 p. Catalog includes advantages, typical installations, mechanical description, construction information, dimensions and selection tables, etc. No. B-102.

  \*Mixing Equipment Co.
- Processing Equipment.....Describes corrosion-resistant processing equipment... precision built to your specific requirements to give long years of peak performance with low maintenance. Technical Bulletins. 387a \*Lee Metal Products Co.
- Propellers . . . . Data Folder describes smooth, vibrationless propellers for stirring, mixing, aerating, etc. Balanced to avoid whip and strain on shafts. In a wide variety of metals, and in sizes up to sixty inches.

  \*Michigan Wheel Co.

\* See explanation on p. 478





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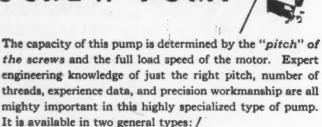
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#### LITERATURE . . .

- Reclaimer Systems, Oil.....A simple, economical and efficient method of restoring contaminated lubricating and sealing oil to the full value of new oil. Offers full details on reclaimers in Bulletin No. R-60.

  401
- Reformers, Koppers-Hasche....Based on a unique adaptation of the cyclic heat-regenerative principle. Company announces availability of new booklet which fully describes its operation when producing heating gas. 437 \*Koppers Co.
- Screens, Vibrating.....For high-capacity screening of a broad range of materials—"CA" vibrating screens are your answer. In complete range of sizes to suit all plant capacity requirements. New Book 2554.

  164a \*Link-Belt Co.
- Screens, Vibrating.....For economical separation of light to medium weight materials—choose "UP" vibrating screens. In open, semi-enclosed, or totally-enclosed types. Complete details contained in Book 2377.

  164b \*Link-Belt Co.
- Separating & Sizing Machinery.....If you process granular materials that must be uniform in length width, or thickness, Hart-Carter sizing machinery may be what you need. Details in Folders CPG-2 and L-1.

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- Separators, Air.....Recover fines in micron ranges. Large feed opening, rugged construction, ease of adjustment, low power consumption assure economy of operation & minimum upkeep. Complete information.

  76a \*Sturtevant Mill Co.
- Support Plates.....The wier-type support plate improves performance of any dumped tower packing. In every size from 12" diameter up to 60" diameter ... has better than 50% free area. New Bulletin upon request.

  102 \*U. S. Stoneware Co.

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  \*Read Standard Corp.
- Compressors, Oil-Free.....Offer spacesaving design, excellent service, economical operation, etc. Company builds regular and oil-free compressors to meet any capacity and pressure need. Bulletin No. A-44. 8 Joy Mfg. Co.
- Fans.....Clarage V-belt "Ready Units" answer economically your smaller air handling requirements. Ready to run, with fan, motor, and drive in one compact, easily installed assembly. Detalls in 28 p. Catalog 515. 80 °Clarage Fan Co.
- Fans.....Exhaust hot, corrosive & explosive fumes the direct way, with no directional change in air stream to cause pressure losses. Bulletin DB-4-53 & "Design Data for Exhaust Systems" sent upon request.

  263 \*American Mach. & Metals.
- Pumps.....Guide to pump selection—big illustrations & brief descriptions with capacties & adaptability of pumps contained in literature to help avoid costly mis-application. Request Bulletin No. S-146.

  \*Taber Pump Co.

\*See explanation on p. 478



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Pumps.....Describes "fiex-i-liner" XB line for pumping corrosive chemicals & abrasive slurries under severe service conditions. Includes design information, capacity chart. Maintenance hints, etc. Illustrated.

501A Vanton Pump & Equipment.

aps..... Handle most anything that can pass thru a pipe, from free-flow-ing liquids to non-pourable pasts— even materials containing relatively large particles or abrasives. Moyno Pump Bulletin No. 30C. 341a PRobbins & Myers. Pumps..

Pumps, Acid.....On most difficult pump-ing Jobs... dependable, highly effi-cient pumps deliver continuous, trouble-free performance on round-the-clock schedules wherever they are installed. Full details. 49 \*A. R. Wilfley & Sons.

Pumps, Acid....Mighty midget for pumping acids. Jabsoo neoprene-impeller pump made of Ace hard rubber outlasts, out-pumps anything in its pressure, size and price class. Full details in Bulietin No. 97. 3960 \*American Hard Rubber Co.

Pumps, Boiler Feed.....For boiler feed and other clear water service against high pressures. In two and four stages to handle up to 500 psi. Capacities up to 900 gpm. Find complete infor-mation in Bulletin No. 980. 412a \*\*Buffalo Pumps.

Pumps, Centrifugal.....Describes line of Impervite impervious graphite centrifugal pumps... with new exclusive seal design—advantages, performance, construction, dimensions, etc. Illustrated Bulletin 854.

Soin. Falls Industries.

Pumps, Centrifugal.....On job after job, 80-gpm centrifugal pump earns highest praise. Hard rubber casing & impelier, Hastelloy C shaft. Handles nearly all corrosives. Complete details in Bulletin No. CE-55.

397b \*American Hard Rubber Co.

Pumps, Centrifugal..... Designed for effi-cient liquid transmission & low cost maintenance, pumps offer many ex-clusive features. Furnishes engineer-ing data on all types of pump appli-cations in Catalog No. 253. 291a

Pumps, Centrifugal..... Specially built centrifugal pumps are used to handle abrasive & corrosive sludges, slimes & slurries. They give maximum pumping service for years. Descriptive Bulletins available on request.

488 \*McNally Pittsburg Mfg. Corp.

Pumps, Centrifugal.....Fully covers line of self-priming centrifugal pumps. Includes data on applications in chemical & process industries, in paper mills, on construction work, in mines, etc. Request Bulletin 210-2.

501C Lawrence Pumps.

Pumps, Centrifugal.....Impervious graphite pumps feature mechanical seal with enclosed coolant, rugged type SN armored connections, inter-changeable parts, wide capacity range, etc. Catalog Section S-7256, 281a \*National Carbon Co.

Pumps, Centrifugal.....Profusely illustrated, 6 p. describes the mechanical features, types and sizes, materials of construction, applications, and advantages of corrosion-resistant chemical pumps. Bulletin No. 310.

501D Dorr-Oliver.

Pumps, Chemical.....Furnishes a complete line of Buffalo pumps, ready to handle corrosive or abrasive liquids at lease maintenance cost. For full product information, request illustrated Bulletins 976 and 982.

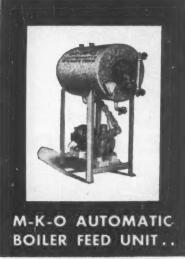
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Pumps, Close-Coupled .....Feature the "Q" Factor . . . the built-in quality which provides trouble-free satisfaction and long life. Offers complete description of Class CCL close-coupled pumps in Bulletin 957-D.

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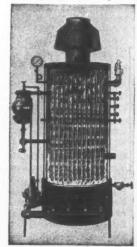
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#### LITERATURE . . .

Pumps, Controlled Volume.....Two new 4 p. bulletins describe how leading paper mills employ controlled volume pumps to meter low capacity flows of papermakers chemicals. Request Data Sheets Nos. F-55-2 & F-55-3.

362A Milton Roy Co.

Pumps, Double Suction......Hydraulically balanced, highly efficient and durable. In sizes to deliver from 10 to 14,000 gpm for circulating, air conditioning, other plant services. Request bulletin No. 995-O.
412d \*\*Buffalo Pumps.

2

Pumps, Double-Suction . . . Describes
Type KS double-suction pumps . . for
air conditioning & other general applications. Includes construction features & bearing & stuffing box details.
Bulletin No. 08B8233.
502B Allis-Chalmers Mfg. Co.

Pumps, Jet.....Covers design, construc-tion, installation & operation of A-S-H Hydro-Ejector—a jet pump designed to pump a mixture of solids & water thru a transporting pipeline. Request Data Sheet Ea. Jets Chlen-Sherman-Hoff Co.

Pumps, Metering & Proportioning.....
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metering and proportioning pumps
... for low maintenance—high performance pumping. Find complete
information in detailed Bulletin No. \*Hills-McKanna Co. 469

Pumps. Paper Stock.....For handling high consistency liquids—save money and trouble with non-clogging paper stock pumps. Available in alloys or rubber-lined for corrosive and abrasive liquids. Bulletin No. 953.

412e

\*Buffalo Pumps.

Pumps, Rotary Vacuum.....Superior design, high efficiences and slow operating speeds make the Beach-Russ Type RP pump the best available mechnical pump for your work. Relates the whole story in Catalog No. 90.

481

\*Beach-Russ Co.

Pumps, Screw.....Covers Standard Gear-in-Head, High Pressure Long Body Gear-in-Head & Standard Vertical Gear-in-Head types Construction, de-sign, features, dimensions, etc. Bulle-tins Nos. S-205 & S-206, 502D Warren-Steam Pump Co.

Pumps, Sealless.....Combining motor & pump in a single unit, Chempump is most significant advance in pump design in half a century. Hard-to-handle fluids can't leak or become contaminated. 16 p. Bulletin 1010.

60-1 \*Chempump Corp.

nps, Vacuum .....In hundreds of major vacuum processing systems ... pumps create low absolute pressures fast and efficiently, and provide quick recovery speed for high production rates. Data in Bulletin V54. Kinney Mfg. Div. Pumps.

Pumps, Vertical Turbine.....Furnishes detailed information on line of vertical turbine pumps. Includes data concerning applications of pumps in air conditioning systems and for many other uses. Bulletin 4700.

490 \*Deming Co.

## Services, Processes, Misc.

Apparel, Industrial.....Made entirely of miracle fabrics...Du Pont Orlon, or Union Carbide Dynel...the new line of Resistall work clothes offers numerous money-saving features. Complete data in illustrated, 8 p.

Resistall Work Clothes.

Apparel, Industrial.....New, illustrated Catalog describes features of Chem-Weave industrial clothing: acid & alkali resistant; lock-stitched-seams as strong as the fabric; unharmed by repeated laundering; etc. 12 p.

502 F Chem-Wear, Inc.

\*See explanation on p. 478

- Autopositive Paper.....Company presents illustrated booklet, "Modern drawing and Document Reproduction," offering valuable information on the line of Kodagraph materials. Covers cost saving features.

  97

  \*Eastman Kodak Co.
- ts.....Lightweight casts for fracture patients now are being prepared from a new cast material made from plastic resin and plaster of Paris. Water-perspiration-, and urine resistant. Request literature.

  24-5e \*American Cyanamid Co.
- Cathodic Protection.....Anaconda Type CP cable and cathodic pretection cut corrosion costs—gas malns and water pipes—lead-covered cable—under-ground storage tanks—etc. Details in Bulletin DM 5450. 121 \*Anaconda Wire & Cable Co.
- Construction, Acid-Proof....Illustrafed
  Corrosion Engineers Manual covers;
  materials (corrosion-proof cements,
  impervious membranes, acid brick,
  acid/alkali-proof coatings); construction basics; etc. 24 p.
  503A Nukem Products Corp.
- Pads & Discs, Polishing.....Fully illus-trated Folder includes information on Kapcor—Gelaco—Amcor polishing pads & discs...the longest last-ing discs & pads made for polishing, rubbing & compound operations. 503B Kammel Products Corp.
- Plants, Chemical . . . . . Expands plant with a minimum of interference to opera-tions—features outstanding record of maintaining operating efficiency dur-ing construction period. Request new chemical Brochure 101. 154
- Plants, Nitric Acid.....Employ well-known Du Pont process, using high-pressure catalytic oxidation, to produce nitric acid. Feature lower capital investment ... lower operating costs New HNO<sub>8</sub> Bulletin. \*Girdler Co.
- Respirators . . . . New interchangeable respirators in both single and double cartridge styles for organic vapors, for for dusts and organic vapors, for dusts and mists, etc. Informative Bulletins furnish details.

  479

  \*Wilson Products.
- Sites, Industrial..... Describes Upper Kenawha Valley of W. Va. with its industrial advantages and facilities available to industry. Contains sta-tistics as to employment, transporta-tion, all resources & a color map 16p. 503C Upper Kanawha Valley Dev.
- Steam Purity..... Dangers of steam contamination & how to prevent or correct them outlined in 6 p. folder, "Steam Purity." Includes symptoms of contamination, kinds of carryover, preventive measures, etc. 503D Hall Labs.
- ste Treatment.....Profusely illustrated manual describes sewage & industrial waste treating methods & equipment—the most complete line engineered & manufactured by a single organization. Manual No. 149.

  503 E American Well Wks.
- Water Treatment, Cooling . . . . Non-Chromate Treatment (Formula 527) . . . for control of corrosion & scale formation in engine cooling systems & elimination of damage to vital operating parts. Bulletin 5014. 503F Dearborn Chem. Co.
- \*See explanation on p. 478

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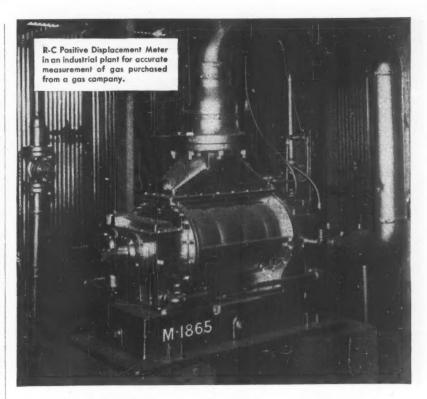
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- 4. Long-time reliability with little maintenance

For "cash register accuracy," these BIG-4 values are essential.

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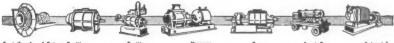
This long-time accuracy is one of the "BIG 4" values which are obtainable only in R-C Positive Displacement Meters, and which are essential to reliable measurements. It prevails unfailingly throughout the entire range of capacities, from 1,000 cfh to 1,000,000 cfh.

For detailed information, ask for Bulletin M-152, which also contains a handy selection table to simplify selection of size and type required.

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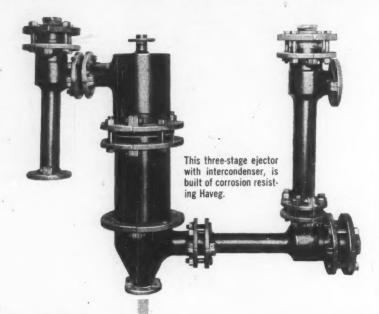
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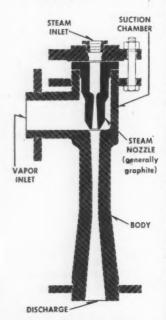
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# ELLIOTT Steam Jet EJECTORS



Cross-section, showing construction details of Type H ejector. Conventional split flanges are used. Nozzle is easily replaceable.

When it comes to maintaining vacuum, while handling highly corrosive vapors, you can't beat these durable Elliott Type H ejectors. Made of Haveg, Permanite or similar corrosion-resistant synthetic resin material, they'll stand up to hydrochloric and sulphuric acids, wet chlorine, caustic, benzene and many other corrosive vapors, including some of the chlorinated aromatic compounds.

Whatever your vacuum requirements, take advantage of the experience and know-how of an Elliott ejector specialist. There's no obligation on your part. Contact your Elliott representative or write Elliott Company, Jeannette, Pa. for descriptive bulletins.

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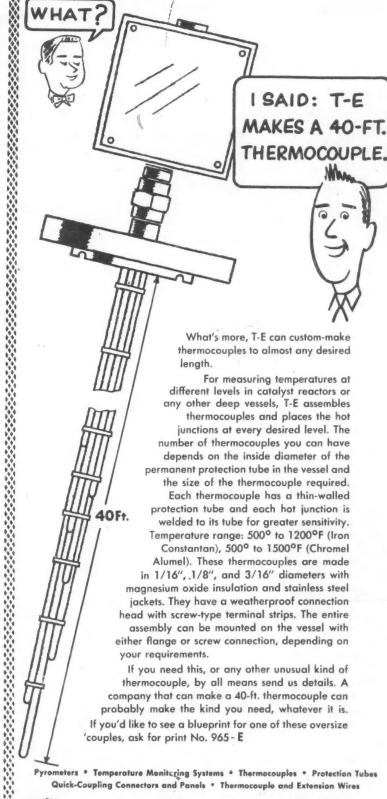
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MINNEAPOLIS, 14

# First Report: "Air Centrifuge installation at McLaughlin Gormley King

I want you to know of the excellent results we are obtaining with the Superior Air Centrifuge which you installed for us some time ago.

Our problem was to recover an extremely fine vegetable dust (more than 90% passes through a 200 mesh screen) which was escaping our cyclone collectors, and was venting to the outside as a loss. Two cyclone collectors are used in connection with a pair of hammer mills which grind our product. Our over-all loss in grinding was from 2% to nearly 5%.

Our present installation uses a Superior Air Centrifuge in connection with a single hammer mill and cyclone and has resulted in the following benefits for us:

- (1) Cut forger over-all loss in grinding by 50% or more.
- Such complete recovery of the dust formerly vented to the outside that the air may now be discharged within the room with resultant heat saving in winter.
- Increased operating efficiency so that the per mill output increased 50%.
- Effected a desired particle separation by collecting the recovered fine dust separately.

Our experience with the Superior Air Centrifuge, as a means of helping to solve our dust problem and in reducing costs, has been very favorable, and I unhesitatingly recommend that anyone who has a dust problem contact your company for help in solving such a problem.

Yours very truly,

MC LAUGHLIN GORMLEY KING COMPANY Dail 6. Labraft
Factory Manager

## "... I unhesitatingly recommend..."

THE ANSWER to your dust problem, too, may be the amazing new Superior Air Centrifuge. This new machine is earning praise throughout the industry for its unmatched performance on solids recovery and dust removal. Certainly, results such as Mr. LaCraft describes are well worth your further investigation.

CONTINUOUS REMOVAL of air or gasborne solids is non-varying over an un-usually wide variety of temperature and humidity conditions . . . temperatures up to 200 degrees higher than with machines employing standard filters. And the Air. Centrifuge maintains maximum efficiency even in the very small particle-size ranges.

THE AIR CENTRIFUGE separates by a patented, impelled-centrifuge principle. And because it works without filters, screens, liquids or electro-static charges, it is adaptable to plant air flow systems wherever machines such as grinders, pulverizers, dryers, purifiers, solvent extractors, mixers, blenders, etc., are involved.

BEFORE YOU BUY any dust removal or particle recovery equipment, get the complete story on the Superior Air Centrifuge.

Call or write for further information.

SUPERIOR SEPARATOR CO. PROCESS MACHINERY DIVISION HOPKINS, MINNESOTA

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## orrosioneering News Quick facts about the services and equipment OPfaudler offers to

help you reduce corrosion and processing cost



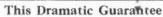
## NOW... process acetic acid in vessels guaranteed against corrosion

Here is another of the many acids against which Pfaudler glassed steel is guaranteed. If you have a process in which acetic acid is the principal corrosive, you should take advantage of this protection.

The unusual new one-year corrosion guarantee now offered by Pfaudler covers acid-alkali-resistant glassed steel reactors and other vessels for handling corrosive products.

We issue this guarantee for services where field and test data have proved that glassed steel will resist ing range agreed upon at time of sale. It is important to note that, even for services where glassed steel cannot be guaranteed, it may still give adequate and economical service life.

Acetic acid is just part of our story dramatizing how Pfaudler glassed steel saves you money. Perhaps you have a process which can operate more economically and efficiently with the greater corrosion resistance of glassed steel. Write us, or consult your Pfaudler representative for further details.



is now provided on equipment for use with a number of corrosives.

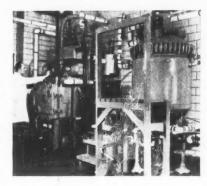
To learn more about the application of glassed steel equipment for your process, write our Rochester office.

## 4 days' drying done in 7 hours

A large manufacturer has been using the new Pfaudler glassed steel conical dryer-blender on a tough job drying a corrosive product containing acid halides. This job took 4 or 5 days under previous methods.

Their engineers report that the new Pfaudler design has reduced this drying time to 6 or 7 hours!

Data on this glassed steel unit is now being offered to all processors interested in reducing drying or blending time. Write The Pfaudler Co., Rochester, N. Y.



## How would you guard product purity in a lab like this?

The equipment you see here gets to do all kinds of jobs. It's in the Biochemistry Development Laboratory at Sterling-Winthrop Research Institute, Rensselaer, N. Y.

Projects at the Institute include monumental tasks like producing antipernicious anemia principle - it takes a ton of beef livers and a 40hour week to produce 1/30,000 of an ounce!

As you can imagine, maintaining purity of the product is extremely important. That's why reactions are carried out in a Pfaudler 100-gallon glassed steel kettle (right). This vessel not only seals out outside impurities, but also prevents metallic contamination. Its hard, smooth surface cleans thoroughly and easily.

If you've a problem of maintaining product purity, perhaps you can find an excellent answer in the chemical inertness of glassed steel by Pfaudler.

# GOOD RESISTANCE 00 BOILING POINT CURVE × w 100 20 30 40 50 60 70 80 90 100 PERCENT ACETIC ACID

The guide chart shown here is based on the use of pure acetic acid 24 hours a day, 365 days a year . . . a more severe test than would normally be encountered in field service.

chemical attack. Naturally, we estimate service life on guaranteed units to be much longer than one year usually 5 to 15.

#### Long service life

Terms of the guarantee provide for free on-the-spot repairs, or factory repairs if necessary (on an F.O.B. factory basis), of any acid-alkali-resistant glassed steel vessel which becomes unusable as a result of corrosion. The guarantee remains in full force until one year from date of shipment, provided your processing conditions do not exceed the operat-

## Nonsticking "utility" pipe costs less

We don't know exactly how much you are now paying per foot for the growing network of piping in your plant, but we may be able to save you money on first costs and cleaning

Because neither glass nor steel is a very costly material to start with, we are able to produce glassed steel "utility" pipe, at a low price that can often save hundreds of dollars on an installation.

Advantages of this pipe are the inherent advantages of glassed steel: NONSTICKING: there are practically no products that can stick to glass very strongly; EASY TO CLEAN: smooth, shimmering surface can often be cleaned just by flushing pipe; DURABLE: the outside of the pipe is good, rugged carbon steel. To keep cost low, a glass of mild chemical resistance is used, providing moderate resistivity

You can now purchase this pipe in lengths up to 10 feet, in diameters of 2", 3", and 4". Two styles are available: conventional type flanged pipe. which is joined by split flanges; or specially designed jointed type for cutting to size and fitting the pipe in your plant.

THE PFAUDLER CO., ROCHESTER 3, N.Y.